NEW SERIES, NO. 133 (VOL. XVII) MARCH, 1921

QUARTERLY PUBLICATION OF THE

AMERICAN STATISTICAL ASSOCIATION

Price $1.50 1921 $5.00 Per Annum

Published quarterly by the American Statistical Association
RUMFORD PRESS BUILDING, CONCORD, N. H.
Editorial Office, New York City
Entered at the post-office, Concord, N. H., as second-class mail matter

THE RUMFORD PRESS
CONCORD, N. H.

NEW SERIES, NO. 133 (VOL. XVII) MARCH, 1921

QUARTERLY PUBLICATION OF THE

AMERICAN STATISTICAL ASSOCIATION

THE BEST FORM OF INDEX NUMBER*

By Irving Fisher

What index numbers are "best?" Naturally much depends on the purpose in view. First let us narrow the question.

Index numbers differ chiefly in: (a) the character and number of data entering into them; (b) the sources and agencies used for collecting the data; (c) the frequency of calculation; (d) the "base" chosen; and (e) the mathematical formula used.

Only the last named, the formula, is here considered.

How widely do index numbers calculated by different formulae differ? Which is (or are) the best?

It occurred to me that new light might be shed on these questions by calculating various index numbers proposed, utilizing the new historical data of the War Industries Board for the years 1913–18.

For this calculation, I have selected thirty-six staple commodities for which complete data, not only for prices, but also for quantities, are given.

The total value of the thirty-six commodities exchanged in 1913 was $13,105,000,000, and in 1918, $29,186,000,000, as obtained by multiplying the prices by the quantities and adding. These figures show an increase of money values in the ratio of 13,105 to 29,186, or of 100 to 223. This 223 per cent is, therefore, the index number of *money value* in 1918 as compared with 1913 as a base.

Our problem is to find how far this ratio of 223 per cent is a matter of inflated prices and how far it is a matter of increased quantities (volume of trade).

It is clear that there can be no ambiguity as to the 223 per cent itself, the index number of money value. There is only one index number of value—the value itself.

* Professor Fisher's paper, read at the Eighty-second Annual Meeting of the American Statistical Association (Atlantic City, N. J., December, 1920), has not yet been completed in all the detail desirable for publication. Hence only an abstract is printed at this time, together with the discussion that took place at the meeting. The full paper with diagrams and data will be published later.—Editor.

It is only when we try to resolve this 223 per cent into two factors, one the index number of prices and the other the index number of quantities, that we find a bewildering multiplicity of methods. We ought, it would seem, to be able to find a form of index number which, when applied alike to prices and quantities, will give results which check up with the 223 per cent in value.

There are a dozen "tests" which we should like to have an index number fulfil. Eight of these are discussed in my *Purchasing Power of Money*. C. M. Walsh's book, *The Measurement of General Exchange Value*, is chiefly on certain tests of a good index number.

But I have come to the conclusion that there are two supreme tests which, practically at least, carry with them the rest:

I. The formula should *work both ways* as to the two factors, prices and quantities.

II. The formula should *work both ways* as to time.

Thus, as to test I, the formula should, as was said, be such that the two figures it yields when used for calculating the index number of (a) *prices* for 1918 and (b) *quantities* for 1918 will, if multiplied together, give the correct figure, 223 per cent, which represents the index number of *value*.

Again, as to test II, the formula should be such that, if used for calculating, say the index number of prices (a) for 1918 in terms of 1913 as a base and (b) for 1913 in terms of 1918 as a base, the two results will be consistent (*i. e.*, will be reciprocals of each other).

The *simple arithmetic* index number meets neither test.

Thus, the arithmetic index number, when applied to prices, would make it appear that, in 1918, the price level was 187 per cent as compared with 100 per cent for 1913; when applied to quantities it would make it appear that quantities had increased to 126 per cent of what they were in 1913.

But if these two figures are multiplied, we obtain not the true index number of money value of 223 per cent as we should, but 236 per cent, which is too high. The harmonics would give a result too low.

Again, suppose bacon is twice as high in 1918 as 1913 while rubber is the reverse—twice as high in 1913 as in 1918. According to the simple arithmetic index number these two commodities were in 1918 $\frac{200\%+50\%}{2} = 125\%$ of what they were in 1913, and at the same time were in 1913 also 125 per cent of what they were in 1918. Each year's price level is 25 per cent above the other's!

In reference to the second test, it may be shown that certain index numbers, including the arithmetic, have an *upward bias*, and others, like the harmonic, a *downward bias*.

It is also true that methods of weighting will introduce a bias. Thus, if the weights used are the values of the *base* year, they impart a *downward bias* to all the index numbers of any given year calculated thereby; while, on the other hand, if the weights used are the values of the given year itself, they impart an *upward bias*.

The reason is, to take the case last mentioned, that the value used in the weighting necessarily contains a relatively high price factor for every high price ratio, and a low for a low. The higher the prices, other things (the quantities) equal, the more they are weighted. It is true that "other things" will not be equal; *i. e.* that the *quantity* element in the weights will have an influence. But this influence is about as likely to be in one direction as the other. This factor, unlike the price factor, is not very definitely correlated with the price ratios which they help weight.

Therefore, the quantity element is of comparatively little consequence in the weights of an index number of prices (or the price element in the weights of an index number of quantities). If I may say so, in an index number of p's we do not need to mind our p's and q's both, but we do need to mind our p's; and vice versa for the index number of q's.

To illustrate, we recur to the bacon and rubber. Suppose that the quantities of bacon are the same in 1913 and in 1918 and the quantities of rubber are likewise the same. It follows that the value of bacon in 1918 was double that in 1913, being proportional to its price and, contrariwise, the value of rubber in 1913 was double that in 1918. To fix our ideas, let us suppose that in 1913 the value of bacon was two million dollars, while in 1918 it was four million dollars, and that the values of rubber were, reversely, three million dollars in 1918 and six million dollars in 1913.

It follows that, with 1913 as a base, the weighted arithmetic index number for 1918, using the values of 1918 (4 for bacon and 3 for rubber) as weights, is

$$\frac{4\times 200\%+3\times 50\%}{4+3}=136\%$$

while the index number for 1913 on 1918 as base, using the values of 1918 (2 for bacon and 6 for rubber) as weights, is

$$\frac{2\times 50\%+6\times 200\%}{2+6}=162\%.$$

These weighted arithmetic index numbers are even more absurd than the previously calculated simple arithmetic index number. According to the simple, each year was 25 per cent above the other; but according to the weighted index number just calculated, 1918 is 36 per cent above 1913, and 1913 is 62 per cent above 1918!

Here are two doses of upward bias, one dose being in the nature of the arithmetic average and the other in the way it is weighted. Yet Palgrave proposed just such an index number, not suspecting the double bias involved.

Summarizing: (1) As to bias, it can be shown that the arithmetic average has an upward bias, *i. e.*, has in the very nature of the arithmetic process a natural tendency to give results too large, that the harmonic has a downward bias, that the geometric, median, and mode have no inherent bias in either direction. (2) As to the system of weighting, it can be shown that a system employing the prices of the base year has a downward bias, and one employing the prices of the given year has an upward bias. (3) Consequently, the only arithmetic index number which is free from the faults mentioned is one with weights in which the prices of the base year are used, such as the index number of the United States Bureau of Labor Statistics; for in such an index number the natural upward bias of the arithmetic process is offset by the downward bias in the method of weighting. (4) Similarly, the only harmonic average free from upward or downward bias is that in which the weights contain the prices of the given year. (5) The geometric, median, and mode, having no natural bias, should be doubly weighted so that the prices of both years enter on even terms.

An index number such as that of Professor Day of Harvard, a geometric with weights dependent on prices at or near the base year, will have a downward bias.

What has just been said relates to conformity to test II. There are likewise many formulae which will conform to test I. But only a few formulae conform to both test I and test II. The simplest of these and the "best" by other tests is

$$\sqrt{\frac{p_1q_1+\cdots}{p_0q_1+\cdots}\times\frac{p_1q_0+\cdots}{p_0q_0+\cdots}}.$$

It is a pleasure to learn that Mr. Walsh, approaching the subject from an entirely different point of view, has recently reached the same conclusion. Mr. Walsh's monumental and memorable book, *General Exchange Value*, showed him many years ago to be a master in this field.

While index numbers by different formulae differ materially, index numbers which conform to either one of the two great tests agree remarkably well. This is especially true of the few which conform to *both* tests.

We conclude that index numbers are far more exact than has been realized. Most of the differences are due not to the formula but to

the number of commodities, or other conditions mentioned at the beginning, and differences due to differences in formulae almost disappear if we get rid of even the crudest bias.

Properly used index numbers are a precise tool, precise far beyond our needs, precise within much less than 1 per cent.

DISCUSSION

By Wesley C. Mitchell

The index number which Professor Fisher proposes seems to me excellent. Indeed, it is "the best index number" known to me for the particular purpose he has in view. Further, that purpose is an important one, covering as it does most of the uses to which what I call "general-purpose" index numbers are commonly put. But I cannot admit that even perfect adaptation of an index number to any use however important entitles it to be called "the best index number" at large.

This issue is much more than a verbal quibble. So far, most makers of index numbers of prices at wholesale have been designing "general-purpose" series. But the time has come when we are beginning to make a wide variety of index numbers especially adapted to particular uses. And we must go further in that direction. In doing such work the compiler should first define as accurately as may be the use which his new series is to serve, and from this use he should deduce the form of index number which is "the best" for him. This criterion of use should determine the number of commodities to be included, the basis on which commodities are selected, the scheme of weighting, and the type of average. What is best in all these respects for one use may be bad for another use. There cannot conceivably be an index number that is "the best" for all uses.

In fine, I think Professor Fisher has tarnished somewhat his excellent contribution by using incautious language implying universal merits in his formula. His very eminence in this progressive field of work makes that slip important. The path of future progress lies in differentiation. Yet if we took Professor Fisher at his word, we should never produce anything but one admirable kind of "general-purpose" series.

DISCUSSION

By C. M. Walsh

In the first place I wish to make an acknowledgment of appreciation for the flattering remarks with which Professor Fisher has referred to my book. In return I must express my wonder at the stupendous labor he has performed in applying so many complex systems of

index numbers to the multitudinous data of the War Industries Board. It has been purely a labor of love, and it is truly admirable. But I could wish he had curtailed it in one direction, and had extended it in another. He might, indeed, have nearly halved his labor without loss. He has shown us that there are four elemental forms of weighting—q_0p_0, q_0p_1, q_1p_0, q_1p_1—two of which are mixtures of the quantities of one period with the prices of another period. These are extremely artificial, and what has happened might have been anticipated—that nothing has been gained by experimenting with them. The other two, which use in their natural connection the quantities and prices of the same period—the one, those of the base period; the other, those of the subsequent period—are the only important forms of weighting; and their employment together constitutes what I have called double weighting. Now, Professor Fisher has well shown that these latter two different weights taken singly—in the case at least of the aggregate system—have opposite defects, the one giving a bias above the truth, and the other a bias below it. This at once suggests taking a mean between them. But the mean between them can be drawn in either of two ways. The one is to carry out each aggregate system by itself, and then to draw a mean between their results. This method is now exclusively used by Professor Fisher. The other is to draw a mean between the two sets of quantities (those of every commodity at the two periods), and then to use the mean quantities in a single aggregate system. This method I almost exclusively used in my book. We both have committed opposite mistakes. It may be—and I am now of this opinion—that the first is the better method. But it needs to be proved that it is. Had Professor Fisher included the other method in his investigations, he might have thrown light on this question.

Consider these two formulae of the aggregate system:

$$(1)\ \frac{\Sigma q_0 p_1}{\Sigma q_0 p_0}, \qquad (2)\ \frac{\Sigma q_1 p_1}{\Sigma q_1 p_0}.$$

The first was advocated by Laspeyres in 1871. The second was adopted by Paasche in 1874. Nothing can be offered in proof of the superiority of the one over the other. They are both wrong, straddling the truth on opposite sides, as clearly appeared in some examples I used in my book, and as has now been demonstrated by Professor Fisher. In his *Elements of Statistics*, published in 1901, Dr. Bowley used the arithmetic mean between them, in this form $\frac{1}{2}\left(\frac{\Sigma q_0 p_1}{\Sigma q_0 p_0}+\frac{\Sigma q_1 p_1}{\Sigma q_1 p_0}\right)$; but he said merely that this "may be" regarded as a "first approximation," whatever that may mean. Previously, in 1887, the British Association Committee on Index Numbers had advised using the arithmetic mean

between the quantities of the two periods, in this form $\frac{\Sigma\frac{1}{2}(q_0+q_1)p_1}{\Sigma\frac{1}{2}(q_0+q_1)p_0}$ (in which, of course, the two $\frac{1}{2}$'s may be eliminated). But they damned their own recommendation by declaring that, after all, weighting is of little consequence. Hence no attention has been paid to either of those index numbers, although they are much better than others that are in use. It is as important to give a good argument as it is to suggest a good thing. Indeed, the good argument is of first importance, for without it the goodness of the thing will not be perceived. Professor Fisher now holds that the geometric mean should be employed in place of the arithmetic as used by Bowley. The superiority of the geometric mean for this purpose I pointed out in my book; and I am glad that Professor Fisher has come to recognize it. I used it in place of the arithmetic as used by the British Association Committee, in this form $\frac{\Sigma\sqrt{q_0q_1}\cdot p_1}{\Sigma\sqrt{q_0q_1}\cdot p_0}$. This was one of my three best index numbers, which Professor Fisher used among his calculations, and the results of which he threw on the screen. The index number which Professor Fisher now advocates is this: $\sqrt{\frac{\Sigma q_0p_1}{\Sigma q_0p_0}\times\frac{\Sigma q_0p_1}{\Sigma q_1p_0}}$. I had referred to this only in a footnote, where, indeed, it stood the test to which I was subjecting various index numbers better than did my three. Recently I have gone over my work, and last year I wrote a pamphlet on the subject, which is not yet published, but which will probably be out within a month. In it I have taken up this very index number and added it to my other three as a fourth theoretically good one, and perhaps *the* best. But this index number was first formulated by Professor Fisher, and has been first published by him. Therefore, it should be known as Fisher's index number.

Now, how do we know that this is a theoretically good system, and perhaps the best one, or the "ideal" one, as Professor Fisher calls it? Here Professor Fisher's method and mine are very different. But I can now speak only of the tests to which it and others are subjected. In the abstract sent to us Professor Fisher used three tests. I intended to criticize one of them as not a test at all, because a test is a trial of the index number on given examples, whereas this is only a requirement. It is the demand for double weighting which I made in my book, and which Professor Fisher now repeats. In his address as delivered he makes this demand, but does not call it a test. He now has only two tests. The one is a special form of Westergaard's test. Westergaard's test is that a result obtained at a distant period

by going over all the intervening periods, comparing each with its predecessor, and piecing the results together in one sequence, should agree with the result obtained by directly comparing the last with the first. But if the results disagree, Westergaard had no way of knowing which is the better one, much less which is the right one. I therefore altered his test by adding as the last period one exactly like the first, both in quantities and in prices. Then we *know* that the price-level and the exchange-value of money are the same as at the first period, and this sameness, which will always be indicated by the direct comparison, ought to be indicated also by the index number employed in comparisons among all the intervening periods, in a string or chain spanning the interval. It happens that even bad systems, which fall down before other simpler tests, will yield the right result at the end of such a chain, while they yield very differing results for the intervening periods. This test, like all other tests, in fact, is only a negative test. It cannot prove an index number, but it can disprove an index number.

It happens also that our very best systems, which meet most of the other tests and agree most closely with one another, only come near to giving the known result at the end of such a chain; but evidently the one that comes nearest, always or nearly always, is the least erroneous. Herein consists the value of this test. It is like the test to which surveyors submit their measurements when they have gone round a field and, coming back to their starting point, require that it should be accurately indicated. It may, therefore, be called the circular test. But in its use an important distinction must be observed. For its full efficacy this test must be applied to at least four periods, at least two intervening periods being different; for then we have at least two transitions that are different, and we come back to our starting point over a different track from that over which we went out; whereas, if it is applied to only three periods, with only two transitions, these transitions are exactly alike except for the mere fact of being reversed. It is true that some index numbers will not stand the test even confined to three periods; but there are others that will stand it so confined, but will fail when it is extended to more than three periods; wherefore this is a more accurate use of the test. This peculiarity attaches to other tests as well, and it was recognized by Professor Fisher when he wrote his book; for in his book he gave a half-mark to the index numbers that satisfy his tests only over three periods and a full mark only to those which satisfy them over more than three periods. Now here he has used this additional circular test—Westergaard's test as altered by me; and he has used it the first time it has ever been

used since I made the alteration twenty years ago. But he has applied it to only three periods. You may be surprised at this assertion, as you can recall no reference or allusion made by Professor Fisher to three periods. But in going from a first period to a second, and then back to the first, and demanding agreement, Professor Fisher has done the same as going on from the second to a third period exactly like the first. But why has he not extended this test to more than three periods? The "ideal" system which he recommends fulfils this test confined to three periods, but does not fulfil it extended to more than three periods. I should be the last person to think that this was a reason for ignoring the full test. Why he has made the confinement, I do not understand.

As for the last test, which Professor Fisher has numbered the first, it is an entirely new one, original, and highly ingenious. I refer to the requirement that when an index number, applied first to the prices, is then turned about and by interchanging the price and quantity symbols is applied to the quantities, the two results multiplied together should yield the total value variation indicated by $\frac{\Sigma q_1 p_1}{\Sigma q_0 p_0}$. This test seems to have some merits, and perhaps might be employed to measure the relative accuracy of theoretically good index numbers. But I have not time to inquire into its merits. Professor Fisher now seems to think it a very important test. In his abstract he seemed to use it almost as the crucial test. He there wrote that as far as he knew the "ideal" index number which he recommends is the only one that fulfils this test. That sounded like an argument for this index number; and I wrote a criticism demolishing it. But yesterday Professor Fisher told me he was aware that there are other index numbers that fulfil this test. What I wrote, therefore, can no longer serve as a criticism. Still, Professor Fisher may not be aware of the great number of index numbers that fulfil this test—a fact which considerably diminishes its importance; and therefore I will read what I wrote, which presents him with at least twenty such index numbers. Not that I intend to describe all these index numbers to you. I will show you only the method of obtaining them.

The "ideal" index number, now recommended at least for its not failing to meet this new test, was formulated, as I have said, in Professor Fisher's book, and it appears in his list with the double number 15 and 16. It is doubly numbered because Professor Fisher points out that it has "the distinction of being identical with its own antithesis." If Professor Fisher will examine more closely into the matter, I believe he will find that for an index number to be identical with its

own antithesis is the same as for it to fulfil this new test. This distinction did not appeal to him then as it does now. But, unless I misunderstand his correlation of price and quantity indexes, this distinction is only apparent, owing to our not having all the formulae of index numbers that we might have. I take it that most of the persons present know that Professor Fisher's list of index numbers in *The Purchasing Power of Money* contains forty-four, arranged in twenty-two pairs of antithetical formulae. The import of this arrangement I have never been able to fathom, especially since, as I have privately pointed out to Professor Fisher, some of the antithetic averages—some of the ones with even numbers—are not averages at all; and his proof that they must be rests on a wrong definition of average. Yet it is interesting to learn that some of the old familiar formulae admit of being thus opposed to each other. Now, the system in question, constituting a pair by itself, numbered 15 and 16, is the geometric mean between the two systems numbered 11 and 12, which together form one pair. It is the only formula in the list that thus draws the geometric mean between the two members of any pair; and this, I think, will turn out to be the reason why it has the distinction referred to. We are not restricted to drawing the geometric mean between index numbers 11 and 12: we can draw it between the members of any other pair, and set the resultant formula up as an index number. I note that the formulae numbered 26 and 28 each contains a misprint, which must be corrected before the right result can be obtained. I throw out the last pair, Nos. 43 and 44, because these are really not averages at all. I also reject the pair consisting of Nos. 9 and 10, because these contain the median, which I for one do not recognize as a mean. The pairs Nos. 11 and 12 and Nos. 15 and 16 having already been accounted for, there remain eighteen pairs. Now, if Professor Fisher will draw the geometric mean between the index numbers in all these eighteen pairs, I believe he will find that in every case the resultant formula will be identical with its own antithesis and will fulfil the new test. Indeed, I believe it to be demonstrable that always the geometric mean between antithetical index numbers must have these properties. And even this is not all; for if he will go on and draw the geometric mean between the formulae obtained from the second and third pairs, and again between those obtained from the thirteenth and seventeenth, he will, I believe, obtain two more index numbers possessing the same properties. We thus have a method for obtaining all the index numbers we please that will be their own antitheses and will fulfil the new test. We merely have to take any index number, find its antithesis in the way prescribed by Professor Fisher, and then draw the geometric mean between the two.

However, I agree with Professor Fisher in considering the index number he calls the "ideal" one the best one. And now, in closing, I will make an appeal for harmony; and I will make an appeal to Professor Fisher against himself. For if I have rightly grasped his conclusion, which was somewhat hurriedly read, he has ended, in spite of his recommendation of this very workable "ideal" index number, by telling us that for practical purposes either Laspeyres' or Paasche's index number is good enough, and that, therefore, as Laspeyres' index number, which uses only the quantities of the base year once for all, is the easier, it should be employed. In his book he recommended Paasche's index number, now he recommends Laspeyres'—its counterpart! If this is the result of all his labors, I regard it as very regrettable indeed. It is true that the figures yielded by these two index numbers applied to the data supplied by the War Industries Board show very slight divergencies from each other and from those yielded by the index numbers which draw a mean between them. But we should note that his investigation has continued over only four years, whereas he recommends these systems for an indefinite term of years. Yet it is a peculiarity of these two index numbers, as of several other bad ones, that their errors accumulate, so that in a long sequence they may become quite appreciable. But in any case, why employ an inferior index number when we possess a better? Mere convenience is not a good reason, and after this display of his patience and perseverance, Professor Fisher is the last one from whom we should expect a compromise with sloth. Perhaps the worst feature in the matter is that until all adopt the best method there never will be agreement; for if you once admit a compromise for mere convenience, there will be different compromises, and the confusion which now reigns in our subject, which is a disgrace to statistical science, will continue. You, gentlemen of the American Statistical Association, have a duty to perform with regard to this subject. Many of you are engaged in statistical work. Many of you advise others who are or will be so engaged. Adopt and recommend the best. Now, in researches into the past the data for a yearly comparison of quantities may not be forthcoming. Then, and then only, you may compromise because you are compelled to do so by the circumstances in the case. You can do only the best the circumstances allow. What index number should you then use? It should be this: $\frac{\Sigma qp_1}{\Sigma qp_0}$. This is the method used by Lowe within a year or two of one hundred years ago. In my book I called it Scrope's index number; but it should be called Lowe's. Note that in it are used quantities neither of a base year nor of a subsequent

year. The quantities used should be rough estimates of what the quantities were throughout the period or epoch. For instance, if you are trying to get the course of the price-level since 1800, you might begin with rough estimates of the quantities for the period 1800–1815—a war period. After that, another set of estimates of the quantities should be used, which might last for ten years. Ten-year terms might be used down to 1875, after which five-year changes might be introduced. These should be still further shortened as you come nearer to the present. For recent years—and especially for the continued use of index numbers into the future—the quantities of every year should be used, and a mean should somehow be drawn between those of every two years. If the geometric mean is antipathetic to you, use the arithmetic, in Bowley's system. The difference between it and the geometric will be but trifling. But, after all, the geometric mean, being used only once in each yearly computation, is by no means beyond the amount of industry we have a right to expect from those who labor with figures. I have no quarrel with Professor Mitchell because, in editing the immense work on the *History of Prices During the War*, he attempted to use Paasche's index number and succeeded in using it only for the first three years, falling into the use of Laspeyres' for the last year, all on the quantities of an intermediate year. He was in a great hurry, and had a right to choose a simple system. But if his work is to become a permanent governmental function—if perchance it should ever be made the guiding principle for Professor Fisher's own scheme of stabilizing the dollar—then we want the very best possible system. Remember then: for the past, use Lowe's index number, and for the present and the future, use Fisher's.

DISCUSSION

By Warren M. Persons

Professor Fisher's analysis of index numbers enables us to use them with greater confidence than we formerly had in the reality of the results. He has shown that they are instruments of precision.

You may have noticed that Professor Fisher has discussed the method of averaging and of weighting index numbers of prices and production without referring explicitly to the *purpose* for which those index numbers were constructed. It seems to me that the methods of averaging and of weighting, as well as the selection of the basic data, all depend upon the purpose to which the index number is to be applied. Moreover, it is evident that Professor Fisher had a specific purpose in mind. His "ideal" index number is an index number that fits into the equation of exchange. He holds that the product of a

price index, P, for any year and the corresponding quantity index, Q, must equal the relative aggregate value, V, of that year with respect to the base period. I agree that this is a legitimate criterion for indices to be used in the equation of exchange, but I am by no means sure that the criterion is one to be applied universally.

As a result of the application of his criteria for a good index number, Professor Fisher recommends as "ideal" the geometric mean between two ratios of weighted aggregates. The weights depend upon a combination of the prices and production in the given year with those in the base year. The speaker, you will notice, referred merely to *two* years in his discussion, although his charts present a comparison of the indices for several years. An index number is not computed merely to compare the index number of one given year with that for the base year but to compare the indices for a series of years with each other. Variable weighting, which Professor Fisher recommends, has the defect that we do not know whether changes in the indices result from changes in prices or production. Also the limitations to dual comparisons imposed by Professor Fisher in his discussion require a new set of weights for every pair of years compared—an endless computing job.

A problem upon which I have been working recently illustrates, first, the necessity, sometimes at least, of securing indices that are comparable each with the other and, second, the confusion that may result from the use of variable weights. I desire to find the correlation between the prices and the volume of production of twelve crops combined. To weight prices by varying production and production by varying prices and then correlate the results is to introduce an unknown element of spurious correlation. I believe that there are better ways of solving my problem than by the use of variable weights—if, indeed, the problem is solvable with variable weights.

Professor Fisher has stated that the arithmetic mean is "biased" upward and the harmonic mean is "biased" downward, without making clear his criterion of bias. The simple arithmetic mean is always larger than the geometric mean, which in turn is larger than the harmonic mean. The *weighted* means, however, are not always arranged in this order. In fact, as Professor A. A. Young has pointed out to me, the arithmetic mean of a number of items is identical with the harmonic mean of those items obtained by using correlative weights. Thus, if $p'_1, p'_2, \cdots \cdots p'_n$ represent the prices of n commodities in any year, and if $q_1, q_2, \cdots \cdots q_n$ represent the quantities of those commodities produced (or exchanged) in the base year, then the

$$\text{weighted arithmetic mean} = \frac{p'_1q_1+p'_2q_2+ \cdots\cdots\cdots +p'_nq_n}{q_1+q_2+ \cdots\cdots\cdots q_n},$$

and the

$$\text{weighted harmonic mean} = \frac{p'_1q_1+p'_2q_2+ \cdots\cdots\cdots +p'_nq_n}{\frac{1}{p'_1}p'_1q_1+\frac{1}{p'_2}p'_2q_2+ \cdots\cdots +\frac{1}{p'_n}p'_nq_n}$$

$$= \frac{p'_1q_1+p'_2q_2+ \cdots\cdots\cdots +p'_nq_n}{q_1+q_2+ \cdots\cdots\cdots q_n}.$$

The weighted arithmetic and harmonic means, with properly chosen weights, therefore, are identical and neither can be called "biased" with respect to the other. When Professor Fisher uses the word "bias," it is not clear to me "with respect to what" the average is biased.

REJOINDER BY IRVING FISHER

First let me thank my critics for their kind words and express my gratification that they agree with me so far as they do. The disagreements which have been expressed are, I believe, in many cases more apparent than real; and I venture to hope that any real disagreements remaining may melt away as the field is threshed over a little more thoroughly.

I am very glad to join heartily with Mr. Walsh in advocating the practical use of what I call the "ideal" formula whenever the necessary data as to quantities for both years are available. It is only when these data are not available—when merely the quantities for the base year are available, that I should propose some other formula as a makeshift.

But Professor Persons and Professor Mitchell are unwilling, at present, to agree with Mr. Walsh and myself on the "ideal" formula as the best for all purposes.

As I understand it, they express doubt rather than disbelief, and make the appeal that the particular *purpose* for which an index number is to be used must surely make a difference.

I quite agree that the purpose of an index number is a very important factor in determining what is the best index number. This is certainly true as to the elements of an index number other than the formula—the character and number of commodities, for instance. But as to the mathematical formula itself, I take a different view.

It is true in the broad field of science, that various types of mathematical averages are best suited for various widely separated purposes.

For instance, to get the average speed of an automobile we should take the *arithmetical* average of the readings of the speedometer taken at short equal intervals of time, such as every second; the harmonic or geometric mean would give false results. On the other hand, we should take the *harmonic* average if the readings of the speedometer are taken at short equal *distances*, such as at every telegraph pole; the arithmetic average as well as the geometric average would then give false results. Again, if we have a weighing balance, or scales, with unequal arms (so that the figure for the weight of an object is found to be different according as it is weighed in one pan with the counterpoise in the other, or vice versa), the true result is obtained by taking the *geometric* mean of the two conflicting results; the arithmetic or the harmonic mean would then give wrong results. Still again, in my *Appreciation and Interest* I have shown that the average rate of interest of a series of successive rates of interest (such as used, for instance, in connection with discounting the proposed German indemnity) is a certain complicated and unsymmetrical average quite different from any suitable for any other purpose, so far as I know.

As to an index number, I would hold that an index number is itself a purpose. It is a purpose sufficiently different from the purposes in the other realms just cited, and sufficiently homogeneous within its own realm, to require certain definite general criteria of its own, whatever the sub-purpose within the domain of index numbers may be.

One could agree to the statement that one system of bookkeeping is good for one kind of business and another for another, without being thereby committed to the proposition that in some businesses one mathematical process should be used and in another, another—that in some the assets should be added together and in others, multiplied. Or, again, one could agree to the statement that one kind of scales is good for one kind of business, and another for another, without being thereby committed to the proposition that in correcting the two readings obtained by weighing in the two pans, the geometric mean is appropriate when we are weighing tea, but some other average must be used for sugar.

I should like to call attention to the fact that neither Professor Mitchell nor Professor Persons has pointed out a single specific case in which the sub-purpose would require that either of the two tests which I have indicated as the supreme tests should be disregarded.

Professor Persons offers, it is true, what would seem at first glance to be a crucial test of my formula for one purpose. He wishes to compute the correlation between an index number of prices and an index number of quantities, for twelve crops; and alleges that my pro-

posed "ideal" formula could not properly be used for this particular purpose. He thinks the correlation would be spoiled by the fact that the index number of prices involves quantities and the index number of quantities involves prices, thus mixing at the outset the two variables whose correlations he is seeking.

A little consideration will, I think, convince Professor Persons that the alleged fault in the formula is imaginary. Suppose that each one of his twelve commodities is such that its price varies inversely with its quantity or crop so that there exists a 100 per cent inverse correlation between the price of the commodity and the quantity—a perfect correlation. Were Professor Persons' misgivings well-founded, we ought to find that the index number of the twelve prices, weighted by the quantities according to the "ideal" formula, would fail to show a 100 per cent inverse correlation with the corresponding index number of quantities. But the fact is that it does show the full 100 per cent required! I shall not take the space to detail the proof. Professor Persons is well able to do this for himself. The case he cites merely adds another to the list of virtues of the "ideal" index number.

I take the liberty to hereby issue a friendly challenge to Professor Persons and Professor Mitchell to demonstrate some particular purpose for which it is desirable that an index number should not work both ways in time, or should not work both ways as to the p's and q's.

These two tests stare us in the face whenever we meet a formula for a weighted index number. For every weighted index number contains symbols for both prices and quantities, and symbols for both the given year and the base year. My tests merely require that, in both cases, the pair of symbols should be treated alike.

The formula which I call the "ideal" is, it is true, not the only possible formula which will conform to both these tests. But all the formulae which do conform to these two tests will yield figures which differ by only a small fraction of 1 per cent.

I believe that we shall reach substantial agreement, from a practical point of view at least, if we can agree merely to discard formulae which fail to conform, even fairly well, to the year-reversal test. We shall thereby rule out all the weighted arithmetic and harmonic averages (except those which reduce to price aggregates) and all geometric averages which do not have symmetrical or "double" weighting. The gross errors in the actual use of index numbers come from disregarding this year-reversal test.

In this connection, I should like to point out what seems to be an error in Mr. Walsh's statement. The "double-weighting" which he stresses so much is valuable for the geometric averages, but it is not

always the best weighting. If, to give a specific example, we are using an *arithmetic* average for an index number of *prices*, the best weighting will be one in which the *prices* of the base year are used. The downward bias introduced by using the prices of the base year will offset the natural upward bias inherent in the arithmetic average. A bias-free weight is as out-of-place with an arithmetic or harmonic average as a biased weight is for a geometric average.

As to Westergaard's test, on which Mr. Walsh lays so much stress and which is evidently considered important by Professor Persons (the test, that is, by which a direct comparison between the base year and any given year is required to yield the same result as an indirect comparison found by multiplying the index number of some third year in terms of the base year by the index number of the given year in terms of the third year), I have come to three conclusions: first, a *complete* fulfilment of that test by a formula for a weighted index number is impossible; second, it is not desirable; and third, the "ideal" index number comes closer to fulfilling this test than any other.

It follows that Professor Persons is demanding the impossible when he asks that an index number on a fixed base should be usable for exact comparisons between two given years. Furthermore, his demand is more nearly satisfied by my proposed "ideal" index number than by any other, and considerably more than by the weighted geometric mean mentioned favorably by him and which Professor Day has employed for his index number of quantities.

For all practical purposes, the "ideal" index number does fulfil Professor Persons' requirement, as the deviation is usually less than half of 1 per cent even under the conditions of wide dispersement of prices and quantities in the war period of 1914–18.

The only forms of index number, out of several hundred compared, which *absolutely* meet the Westergaard test (*i. e.*, are not subject to "the limitations to dual comparisons" complained of by Professor Persons) are the *simple* geometric, median, mode and price-sum! No one has claimed, or could claim, that these are superior to weighted averages.

Professor Persons speaks of the simple geometric mean as lying between the simple arithmetic and harmonic means, and then remarks that "the weighted means, however, are not always arranged in this order." This statement is erroneous if it is assumed that the *same weights* are used in the three means compared. In the instance cited by Professor Persons, where a weighted arithmetical average is identical with a weighted harmonic, the weights are different in the two cases. This instance is like that cited in my *Purchasing Power of Money*

(formulae 11 and 12, see pages 395 and 397 and headings 11 and 12 of table opposite page 418). In this and other like cases the bias of the arithmetic or harmonic average is counterbalanced by the opposite bias of the weighting used.

Where quantities for the given years are not available, so that what Professor Persons calls "variable" weights cannot be used, an index number very close to the ideal and free from any gross bias can be used, namely, the above mentioned arithmetical average, the weights being the values of the base year, which is identical with the harmonic average, the weights being the products of the quantities of the base year multiplied by the prices of the given year, which is identical also with the price-aggregate index number. This is superior to the geometric average with base-value weights favored, apparently, by Professor Persons. This geometric average is inferior just because it has no bias to neutralize the downward bias of the base-value weighting (associating, as that weighting does, high prices with low weights, and low prices with high weights).

In further reference to Mr. Walsh's criticism, I would say that there is much in my full paper which was not given at the Atlantic City meeting, partly because of lack of time and partly because the calculations have not all been finished. The calculations include those for Westergaard's test and formulae in which the mixture of the base year and given year is accomplished *in the weights* and not by taking the geometric mean of the completed formulae. I had no thought of using the former method "exclusively." I think the complete paper will also show that the work of calculating all four, instead of only two, of the weighted averages was not wasted.

Mr. Walsh is right in noting a slip which I made in the first abstract sent to those who were to discuss my paper at Atlantic City. But the slip was not quite what he took it to be. There are, of course, very many index numbers which fulfil *one* of the two supreme tests. I was speaking of formulae which fulfil *both* tests. What I should have said is that there are only a few such formulae and that among them the "ideal" is distinguished by its simplicity and by the fact that the two components of which it is formed are very close together to start with, as well as by other virtues, all of which may be fairly said to make it unique.

I hope I have, by this time, made it clear "with respect to what" an index number may be called "biased." It is with respect to its own assumed standard. If Professor Persons will collect data for the varying prices and quantities in any two towns of the United States, such as Boston and New York, he will find that any among what

I have called "upward biased" index numbers will make Boston appear to have a higher price level than New York (if New York prices are assumed as the base) and yet make New York appear to have a higher price level than Boston (if Boston prices are assumed as the base); while, reversely, the downward biased index numbers will make each city lower priced than the other! Is it possible that an index number can be good for *any* purpose whatever if it is so consistently inconsistent as to make every town higher priced than every other? Such an index number stands self-condemned!

THE MEASUREMENT OF VARIATIONS IN THE NATIONAL REAL INCOME*

By Edmund E. Day

The high significance commonly attached to variations in the national real income invites an examination of the means by which such variations are to be measured. Undoubtedly, definite conclusions must await the collection of additional data, along new as well as accustomed lines. But meanwhile various problems of method may be profitably entertained and working rules of analysis provisionally devised.

Variations in the national real income are to be ascertained by two distinct methods. In the first place, measurement of the variations is possible through an analysis of pecuniary aggregates. The national *money* income may be reduced to *real* terms through the process of deflation; that is, through dividing the money income by numbers proportionate to changes in the price level. Since the prices of different lines of goods and services behave differently during periods of general price change, special index numbers for various commodity- and service-groups are necessary if the national real income is to be accurately determined by this method of deflation. It may be questioned whether special index numbers, satisfactory for this particular purpose, are now available. But there is no reason why they cannot be constructed. Once on hand, they would render possible an approximate measurement of the national real income. An early determination of the national real income by this method of deflating the national money income is much to be desired.

The second method of ascertaining variations in the national income is by the process of direct summation of the goods and services. Of course, the goods and services cannot be combined in physical terms. It is impossible to obtain an absolute total of the real income, made up, as it is, of flour and meat, clothing and coal, automobiles and movies, and a thousand and one other diverse objects of desire. The absolute national real income is to be expressed only as a complete list of things consumed; it cannot be stated in a single figure. But *relative variations* in the national real income may be ascertained by combining relatives indicative of the volume of consumption of the different goods and services that constitute the real income. Moreover, such varia-

* Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

tions in the real income may be expressed in a single index number. Some indication of the steps involved in this method of direct summation is provided by the analysis which follows.

Something should be said in the first place regarding the general nature of the national real income. Real income is unmistakably psychological in character. It consists of satisfactions derived from the utilization of goods and services. But what goods and services? The distinctions between free and economic goods, public and private goods, durative and consumptive goods, producers' and consumers' goods, all contribute to an answer. In general, the national real income during a given period consists of the satisfactions derived from the use during that period of consumptive and durative consumers' goods and services, whether publicly or privately distributed.

Obviously, this concept can be only roughly approximated in any statistical measurements at this time. In the first place, measurement of satisfactions is clearly impracticable. Analysis must content itself with measurement of the physical sources, or externals, of such satisfactions—with the concrete goods and services. In the second place, it is impossible to calculate the annual increment from durable goods. The accumulated stock of such goods may be ascertained; or the annual increment of new durable goods may be measured. But the general rate of utilization lies beyond statistical reach. Finally, most services are not now so recorded as to permit of statistical tabulation. True, data may be had on such services as are provided by the railway and telephone systems. But the personal services rendered by lawyers, physicians, teachers, artists, actors, and household servants are indicated only in the numbers occupied in the several branches of professional and domestic service. No available records show variations in service-income due to the varying activity of those engaged in the service-occupations. It is obvious, then, that the national real economic income as statistically measurable is considerably different from the same income as theoretically defined. Nevertheless, in view of the surpassing importance of the subject, an attempt at statistical measurement seems desirable.

So far as the national real income is embodied in goods, the most important single barometer of changes in the size of the income is the physical volume of output in manufacture. This follows from the fact that the great bulk of modern articles of consumption pass at one stage or another through factory processes. Even our foodstuffs—our flour, meat, sugar, coffee—emerge in finished form from industrial plants. Only a few commodities—fresh vegetables and fruits, milk, household coal—are not regarded as in any way manufactured. The production

of all others—the bulk of our food, our clothing, our shelter—involves manufacture. The physical volume of factory output bears a definite relation to the national real income. Examination of an index of the physical volume of manufacture promises to contribute to a knowledge of variations in the national real income.

Such an index has been constructed in the course of an analysis of the physical volume of production for the period 1899 to 1919.* Separate indices have been developed for agriculture, mining, and manufacture. The index for manufacture is based partly upon material drawn from the United States censuses of manufactures for 1899, 1904, 1909, and 1914, and partly upon thirty-five series of annual data, available in practically all cases for the full period 1899–1919. The index takes the form of a weighted geometric mean of relatives obtained by reducing each item of every original series to a percentage of the 1909 item of the series. The index is obtained by a process of integration. Indices for individual industries are secured from series representing single commodity lines. Indices for groups of industries are developed by combining single-industry indices. Finally, the index for all manufacture emerges when the group indices are consolidated. Throughout the computations, the weights employed are proportionate to the values added by manufacture as shown in the census of manufactures for the base-year 1909. By means of corrections introduced at two points in the computation, the index based upon annual data is made to conform exactly for census years to the index based upon census data. The more abundant material of census years is thus made into a series of solid abutments upon which the index based upon annual data is suspended. The annual data serve to determine the year-to-year fluctuations of the index; the census data, the general level upon which the index moves.† The index, thus developed (shifted to the base 1899 = 100), is given in full in Table I, and shown graphically in Chart A.

The significance of the index for manufacture is best understood by comparing it with the corresponding indices for agriculture, mining, and population—all shown in both table and chart. The contrasts are striking. In the general course of the physical volume of production, manufacture lies between agriculture upon the one hand and mining upon the other. Agricultural production from 1899 to 1919 increased at a rate almost exactly paralleling the growth of population. The exploitation of our mineral resources, upon the other hand, proceeded at a pace greatly in excess of the rate of increase of population.

* *The Review of Economic Statistics*, September, October, November, December, 1920, January, 1921.

† For complete details regarding the construction of the index of physical production for manufacture, see *The Review of Economic Statistics*, November 1920, pp. 309–337.

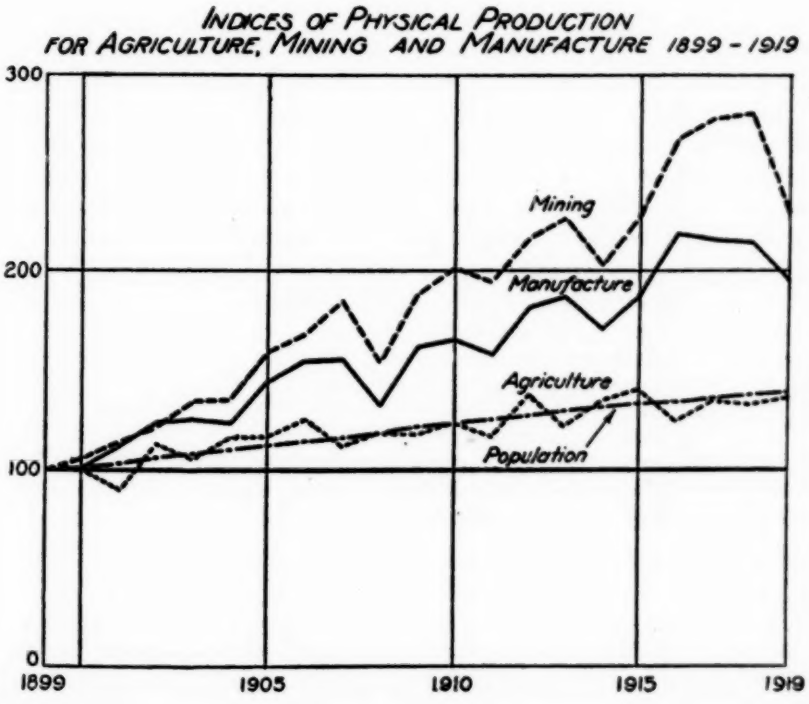
TABLE I

INDEX OF PHYSICAL PRODUCTION FOR MANUFACTURE, COMPARED WITH CORRESPONDING INDICES FOR MINING, AGRICULTURE, AND POPULATION, 1899–1919

(Items for 1899=100)

Year	Index for manufacture	Index for mining	Index for agriculture	Index for population
1899	100.0	100.0	100.0	100.0
1900	101.0	105.7	100.6	101.8
1901	112.4	114.6	89.3	103.8
1902	123.5	122.7	113.7	106.0
1903	125.5	135.0	105.0	108.1
1904	123.2	136.3	116.0	110.3
1905	144.4	161.6	117.5	112.4
1906	155.0	169.9	125.0	114.5
1907	156.3	185.9	112.4	116.7
1908	132.7	154.2	118.8	118.9
1909	163.4	189.4	118.1	121.0
1910	166.0	201.6	123.2	123.1
1911	158.3	194.4	117.0	125.3
1912	181.4	216.7	138.1	127.4
1913	187.1	227.2	122.1	129.6
1914	171.4	202.6	135.0	131.6
1915	187.2	227.6	141.0	133.2
1916	218.6	267.0	124.9	134.8
1917	215.2	277.2	135.0	136.5
1918	214.0	279.6	133.2	138.1
1919	195.3	228.4	137.6	139.7

CHART A



Manufacture, depending for its raw materials partly upon agriculture, partly upon mining, naturally assumes an intermediate position. Its rate of increase has been much more rapid than that of the population and considerably greater than that of agricultural production, but not nearly so great as that of mineral output. In the year-to-year fluctuations, also, distinct differences appear among agriculture, mining, and manufacture. The course of physical production in manufacture is markedly cyclical. The same is true in mining. As might be expected, mining appears to be little more than the handmaiden of manufacture. Agriculture, on the other hand, exhibits fluctuations from year to year which appear to be almost, if not entirely, independent of the business cycle. In general, the differences between the indices are highly significant, and suggestive of fundamental facts relating to variations in the national real income.

But if changes in the national real income are to be clearly recognized, a more detailed analysis must be made. Although the physical volume of production in manufacture has a bearing upon the measurement of variations in the national real income, the bearing is not a clear and direct one owing principally to the fact that the output of manufacture consists of producers' as well as consumers' goods. Stronger light will be thrown upon variations in the national real income if the general index for manufacture is broken into the ten group indices upon which it is based. These ten group indices serve to register fluctuations in the physical volume of production in certain important groups of manufacturing industries recognized in the census classification of manufactures. The ten groups for which sufficient data have been obtained to warrant the construction of indices are those engaged in the manufacture of the following products:*

1. Food and kindred products (1)
2. Textiles and their products (2)
3. Iron and steel and their products (3)
4. Lumber and its remanufactures (4)
5. Liquors and beverages (7)
6. Chemicals and allied products (8)
7. Stone, clay, and glass products (9)
8. Metals and metal products other than iron and steel (10)
9. Tobacco manufactures (11)
10. Vehicles for land transportation (12)

The indices for these ten groups, reduced to the base of 1899 = 100, are given in Table II and presented graphically in Chart B.†

* The figures in parentheses refer to the numbering of the groups in the full census classification. The census groups for which annual data are not available are: (5) Leather and its finished products; (6) Paper and printing; (13) Railroad repair shops; (14) Miscellaneous industries.

† The indices for the lumber and vehicle groups are omitted from the Chart.

TABLE II

INDICES OF THE GROWTH OF POPULATION AND THE PHYSICAL VOLUME OF PRODUCTION OF TEN GROUPS OF MANUFACTURED PRODUCTS, 1899–1919

(Items for 1899=100)

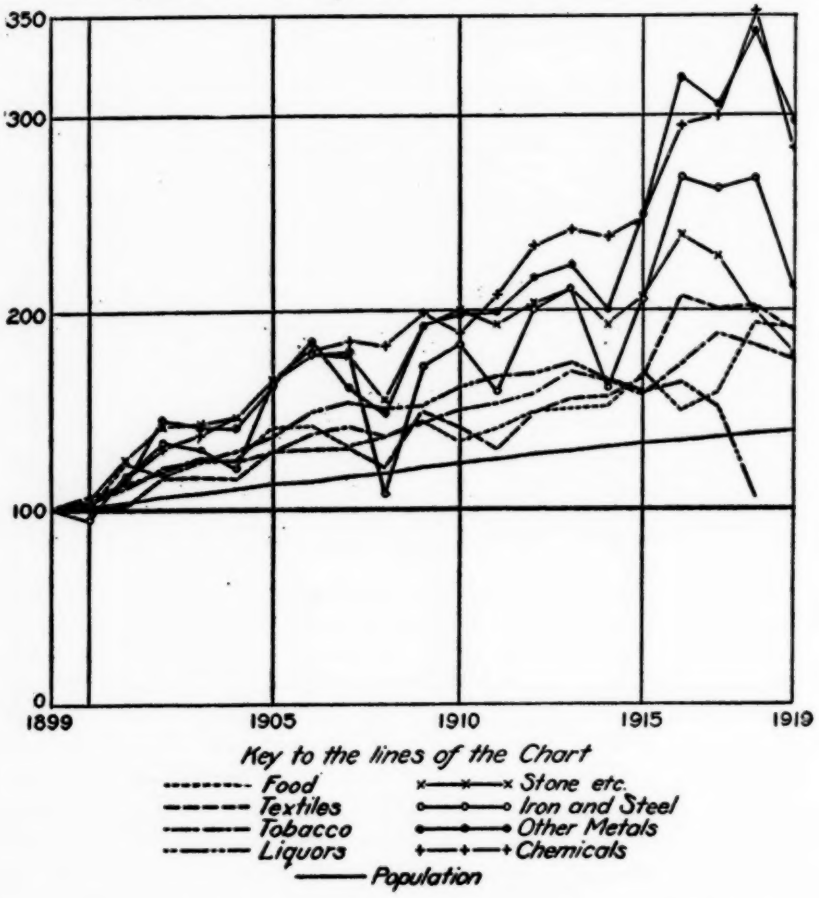
Year	Population	Lumber	Food	Textiles	Tobacco	Liquors	Stone, clay, and glass	Iron and steel	Chemicals and allied products	Metal products other than iron and steel	Vehicles
1899..	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1900..	101.8	98.1	100.7	100.6	106.5	105.7	105.4	95.5	102.6	102.3	117.4
1901..	103.8	96.2	123.1	101.5	112.0	112.9	125.2	117.5	115.5	113.1	147.2
1902..	106.0	94.3	117.3	116.0	118.1	120.9	142.0	133.3	130.2	145.8	183.3
1903..	108.1	92.4	124.5	116.1	126.0	125.6	143.1	130.2	138.6	142.4	210.3
1904..	110.3	90.7	125.0	115.8	124.8	129.4	146.8	120.4	146.6	141.4	186.5
1905..	112.4	97.4	141.3	129.2	128.4	137.6	165.3	164.2	165.5	163.9	284.4
1906..	114.5	109.1	142.1	130.4	138.2	149.4	178.4	178.7	180.4	184.7	356.7
1907..	116.7	115.8	132.2	131.9	141.8	153.6	177.4	179.7	184.4	161.8	430.5
1908..	118.9	112.4	136.2	121.5	136.3	149.3	155.3	107.7	182.0	148.5	286.8
1909..	121.0	126.2	144.3	149.2	143.6	151.5	192.6	171.8	199.2	192.6	354.5
1910..	123.1	123.2	134.3	141.2	150.7	161.6	200.7	183.2	189.6	198.4	522.2
1911..	125.3	116.1	140.4	130.3	153.7	165.6	193.2	159.6	208.3	199.0	377.6
1912..	127.4	118.7	149.5	148.4	158.6	168.5	204.0	201.0	233.4	216.3	650.6
1913..	129.6	113.4	151.0	155.8	169.1	173.4	211.2	211.2	240.6	223.9	769.8
1914..	131.6	101.8	152.7	157.3	165.0	164.5	193.8	161.3	238.8	200.3	657.8
1915..	133.2	95.6	169.7	167.8	158.8	158.3	208.6	205.3	247.8	248.1	747.4
1916..	134.8	100.6	150.8	207.6	173.4	163.8	238.1	268.9	294.8	319.0	1304.6
1917..	136.5	90.5	159.5	201.4	188.8	151.2	227.5	262.7	299.0	305.0	1483.3
1918..	138.1	80.4	194.2	202.7	183.0	105.0	200.5	267.9	353.8	343.5	1019.5
1919..	139.7	85.5	191.1	190.7	176.0	....	178.8	212.7	282.2	296.1	1373.8

The outstanding feature of these lesser indices is an unmistakable grouping in the movement of the indices during the pre-war period 1899 to 1913. Examination of the indices shows that, while the index for vehicles rises to an extraordinary height, and the index for lumber remains upon an unusually low level, the other eight indices fall into two well-defined sets,—one consisting of the indices for iron and steel, stone and clay, non-ferrous metals, and chemicals; the other, of the indices for food, textiles, tobacco, and liquors. The distinction between the two sets is clear. The commodities produced in the first set consist primarily of producers' goods; those in the second set, of consumers' goods. It follows, of course, that the second set of group indices has a much more direct bearing upon the national real income than the first.

Careful examination of the various group indices for the full period 1899 to 1919 yields a number of interesting tentative conclusions. In the first place, the production of producers' goods has increased at a much more rapid rate than the production of consumers' goods. Presumably those portions of the national real income which consist of services derived from large-scale plants, such as railroads and telephone systems, share in the very rapid increase of volume which distinguishes the indices of this class. In the second place, it may be concluded

CHART B

Indices of Physical Production for Important Groups of Manufactures. 1899 – 1919



that the rapidly increasing output of *producers'* goods, used partly to maintain, partly to enlarge, existing industrial plant and equipment, has the indirect consequence of increasing the domestic manufacture of *consumers'* goods. It is not surprising, therefore, to find the production of consumers' goods apparently increasing more rapidly than the population.* In the third place, the group indices confirm the conclusion, previously drawn, that the manufacture of goods made from mineral raw materials has increased more rapidly than the manu-

* This more rapid increase cannot be fully accounted for by the tendency for consumers' goods to pass in more and more complete measure through manufacturing processes and commercial exchange.

facture of goods made from agricultural raw materials. In the fourth place, the fluctuations of manufacturing output which mark the business cycle, though conspicuously greater in the industries producing capital goods than in those producing consumption goods, appear to be so considerable even in the latter industries as inevitably to involve year-to-year variations in the volume of goods passing to the consumer. These conclusions, general and tentative as they are, make a beginning in the analysis of changes in the national real income during the past twenty-one years.

Taken as a whole, the results of the study of the physical volume of manufacture are intended to suggest a practical mode of analysis rather than definitive conclusions. For the reliable measurement of the national real income, investigation must be extended to include: (a) fluctuations in the stocks held by manufacturers, jobbers, and retailers; (b) changes in the physical volume of exports and imports; (c) variations in real income in the form of personal services. Reasonable approximations, if not full measurements, of these elements are becoming more and more feasible. With these elements included, the analysis should produce highly significant results. Direct measurement of the variations of the national real income is one of the lines to be most carefully cultivated by current statistical investigation.

A NATIONAL MONEY ACCOUNTING AS THE BASIS FOR STUDIES OF INCOME DISTRIBUTION*

By M. C. Rorty

A recent writer has revived,† in very interesting fashion, an old discussion as to whether man, as we know him, originated from solitary or from social progenitors. He argues, rather convincingly, from evidences of language and primitive customs, that the ancestors of man must have been highly socialized animals living much like the bee and the ant, and that the man-like apes represent side branches, or outlaws, from the evolutionary tree.

This discussion, aside from its purely scientific interest, has its very practical aspects. We shall have one very definite attitude toward present day political evolution if we believe that society is developing from a primitive individualism toward a highly socialized form. And we shall have quite a different viewpoint if we see in human evolution a steady progression from a primitive and excessive socialism toward a scientific individualism which shall combine a large measure of personal freedom of initiative with the advantages of collective effort, where collective effort is required. In the one case, the Marxian type of socialism represents at least a tendency toward progress; and in the other case, it represents economic infantilism, a mere atavistic recoil from economic growing pains.

These two viewpoints are, in some respects, as widely separated as the poles. Yet they have common ground in an agreement that the ultimate test of any social or political plan must lie, first, in the gross production of the tangible and intangible things (goods, services, and gratifications) that satisfy normal and proper human desires; and, secondly, in the equalities and inequalities of the distribution of such gross production among individuals and families. Opinions may differ as to the relative weights that should be assigned to tangible and intangible products. They may differ, also, as to what uniformity of distribution is equitable or socially desirable, as to how far a diminution of the present inequality might increase production, and as to the extent to which gross volume of product should, if necessary, be sacrificed for the sake of such uniformity. But they must agree as to the vital need, from year to year, and from generation to generation, of

*Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

† Ford, Henry Jones, *Natural History of the State.*

reliable and accurate measures of the production and the distribution that is taking place.

The fact that all shades of political theory have this common meeting ground has, in recent years, lent special interest to the studies of income distribution such as those of Dr. King in the United States, and of Professor Bowley in England. This interest attaches, also, to closely related investigations such as those recently made by Professor Friday. But, in spite of this general interest, too little attention has yet been paid to the necessity for the establishment, in such analyses, of a definite procedure that will permit significant comparisons to be made between the results of successive investigations. In measuring the effects of social, industrial, and political changes, it is much more important to maintain continuity and comparability in successive studies than it is to secure an ultra-refinement of accuracy in any single one of the series. With this necessity in mind, the writer is attempting to suggest the more important details of method that should be observed in studies of income and income distribution. He also presents, briefly, the reasons for centering such investigations around that semi-exact national money accounting which is becoming more and more practicable with increasing accuracy in income tax statistics and increasing publicity in respect to financial and corporate activities.

In approaching this general problem, the first necessity is obviously for a consideration of those progressive changes in the forms of national income which may affect the comparability of present and future studies.

If we go back only as far as early Colonial days in this country, we find that the bulk of the real income of the population was not in money, but in the products of farms and home industries consumed directly by the producers and their families; and today there are still many isolated and almost self-contained farms that produce comfortable livings, even if they produce very little in the way of actual money income. The use of urban home properties by their owners and the services of housewives to their families are other large items. All of these elements in the national product are real. Furthermore, each item is tending year by year to assume new forms that are measured in terms of money. Farm and urban tenantry is increasing. The self-contained farm is giving way to the farm that specializes on money crops, and even the housewife is seeking gainful employment and is buying the family meals at the delicatessen-shop.

Besides these changes, there are others of a different sort that are quite as fundamental. In an advancing civilization there is naturally

less and less of our national effort devoted to the production of necessities, and more and more to the production of luxuries, to education, to governmental services and activities, and to entertainment. We are spending larger sums each year for sanitation, for police and fire protection, and for good roads. We may even continue to spend increasing sums for improved varieties of warfare. Moving picture exhibitions and great battles are, in fact, as truly a part of the national product as are bread and meat. A survey of the national product a generation ago might perhaps have shown a per capita output of fundamental necessities not very different from the present, but a comparison on this basis would be entirely misleading.

When all of these factors have been considered, it becomes evident that we must have an initial broad definition of the tangible (annual) national product, which definition must include:

a. The output of goods for individual consumption.

b. The output of items of non-productive and non-consumable, or only slowly consumable, wealth; *i. e.*, jewelry, pleasure automobiles, etc.

c. The output of productive structures and machinery, less replacements; *i. e.*, the net increment of such items.

d. The value of all private and corporate services to individuals.

e. The value of all governmental services to individuals.

f. The annual value of all direct individual use of productive property and machinery; *i. e.*, mainly the use of home property by its owners.

g. The net income (positive or negative) from international investments.

h. The net earnings (positive or negative) through international interchanges of the services of capital and persons; *i. e.*, mainly with respect to shipping and cable facilities, but including also sums paid in respect to patents, copyrights, etc.

i. Net balances (positive or negative) with respect to taxes paid by, and governmental services furnished to, colonies, protectorates, and dependencies.

Several of the items in the preceding definition require explanation in detail, and there are certain general considerations that affect the definition as a whole.

As to the general considerations, it is necessary to note, first of all, that the national product can be measured only as and where it serves individuals, *i. e.*, at the point where individual consumption occurs or final title is taken. The real products are not wheat on the farm and cloth in the factory, but bread on the table and clothes on the backs of human beings. Coal at the mine has no final or definite meaning, from the standpoint of human subsistence and comfort. Some is used for the heating of homes, but much is consumed in its own transportation to the point of use, and still more is consumed in the production of other final products and services. Also, through the operations of international trade, many of our domestic products take, in large

part, new forms before they pass into the hands of our individual users.

Similarly, with regard to necessary replacements of productive structures and machinery, there is no essential economic difference between the coke that is burned in a blast furnace and the blast furnace that is worn out in the iron-making process. The labor and raw materials that enter into both appear finally in finished iron and steel products, and should not be counted a second time in summing up the national output. Replacements of non-productive wealth do not, however, fall under this ruling. This difference may be made clear through a comparison of motor-trucks and pleasure automobiles. Necessary replacements of motor-trucks are an integral part of trucking costs and are reflected finally in commodity prices; but the wearing out of a pleasure automobile is exactly comparable to the wearing out of a suit of clothes or to the consumption of a loaf of bread. Therefore, in general, the entire output of pleasure vehicles should be included in the national product, while the output of commercial vehicles can be counted only in part.

Still a further point applying to the broad definition of the national product is the necessity of valuing the whole in terms of a common money denominator. No valuation of the national product, or picture of its distribution, could have a workable meaning if it were in terms only of loaves of bread, suits of clothes, and tons of domestic fuel. Furthermore, many of the items, such as the use of residential property, and most forms of private, corporate, and governmental service, have no practical measure except in terms of money; whereas other items, such as the net balance of income on international investments, are primarily in the form of money, even if later they are converted into commodities. This necessary summing up of the national product in terms of money carries with it the necessity for an interpretation of the final result in terms of a proper price index. The nature of this index may, however, be discussed more appropriately at a later point in this paper.

All of the preceding considerations tend, in the end, only to emphasize still further the need for a comprehensive definition of the national product, such as that previously outlined. Yet it is equally obvious that such a definition does not offer a practicable primary basis for the studies that must be made. The distribution of the total product must, in any case, be determined very largely from statistics as to actual and equivalent individual money incomes. Furthermore, it is almost impossible to make a direct summation of physical products, and it is still more difficult to value them at the points where final

titles are taken. Such a summation might conceivably be made if there were accurate records of all retail and other final transactions; but it is only necessary to be told that there are approximately 2,000,000 retail establishments in the United States to realize that such an approach is entirely unworkable today, and probably will continue to be very difficult in the future, even with a considerable development of sales taxes and other new sources of statistical information. And, finally, there are properly included, in the broad definition, many items that cost money and consume human effort, but are of very doubtful real value. To consider only one such item, the services of courts, jails, and policemen are units in the sum of governmental activities quite as truly as the services of the public schools, in spite of the fact that one class of service is highly productive, while the other is merely an attempt to reduce waste.

With these difficulties in the direct summation of the national product once recognized, the alternative procedure which suggests itself is to work primarily through a summation of individual money incomes and to supplement and check the results so obtained by means of other data.

It is at this point that the very helpful concept of a national money accounting first comes in. Such an accounting is, in effect, a detailed analysis of the continuing round flow of money from individual money incomes to individual expenditures, through the accounts of individual and corporate entrepreneurs and governmental agencies, and back again by sources—salaries and wages, rents, interest, dividends and profits—to individual incomes. The balances involved are necessarily those of a cash accounting, and incomes, for this reason, must be measured in terms of receipts rather than accruals. Certain entirely practicable adjustments must also be made for credit expansion and contraction, for the effects of international investments and international trade, for "invisible" trade balances, for corporate surpluses, etc. But with these factors once recognized, the procedure is such as to enable effective use to be made of practically every source of statistical information that is available. Furthermore, the method in question has the very special advantage that it enables many items of information to be cross-checked and balanced in the early stages of their use before they are combined in the final summations.

Limitations of space and time necessarily prevent a full discussion of details in the present paper. Such discussion would, in any case, come more appropriately from Professor Mitchell and his corps of assistants, who are at the present moment developing and applying some features of this method in connection with a new study of the national income.

In general, however, the procedure involves three steps: first, a summation and distribution of individual money incomes; second, a summation of individual expenditures, counting savings as expenditures by indirection, which summation may in practice be arrived at through a summation of that portion of the national product to which title is taken directly or indirectly by individuals in return for money payments; and, finally, a summation of individual money incomes by sources. The fact that all of these summations are tied together in the money accounting makes it possible, as previously noted, to apply many very effective intermediate checks. For a single example, available statistics concerning individual incomes make it possible to determine with considerable exactness the relation between total income from personal service, and total income from interest and dividends; and these figures may be very closely checked through studies of the relation between the disbursements of individual and corporate entrepreneurs with respect to interest, dividends, and profits on the one hand, and to salaries, wages, and their equivalent on the other. The particular effectiveness of this check arises from the fact that the variations, between different establishments, in the relative disbursements to capital and labor are not only very much less, but also very much more easily determined, than are the variations in the percentages of return on total invested and borrowed capital.

When the details of procedure with regard to the money accounting have been determined, the final problem is that of the adjustment and interpretation of the results.

The major adjustment that is required concerns certain forms of tangible income that do not appear as money. The largest and most important items of this kind are the use of home properties by their owners, and the consumption of food products and fuel by agricultural producers. These adjustments must be made in terms of the amounts that are paid as rents for equivalent home properties occupied by non-owners, and in terms of the prices that are paid for equivalent fuel and food by the general population; otherwise, comparability will be lost not only between various groups in the population, but also between successive studies and between nations that differ widely as to the proportions of their workers that are engaged in agricultural and industrial pursuits. The general principle in this respect is to supplement money incomes by valuations of all forms of tangible non-money income that do now involve, or may in the future involve, money expenditures on the part of any considerable proportion of the population.

A further somewhat similar adjustment that might be required concerns the tendency for the services of the housewife to the family

to be replaced by hired services, while she undertakes gainful employment. This correction may, however, be avoided by making the studies in terms of individual rather than family incomes. The question of family incomes and of family standards of subsistence must, in any case, be a subject for supplemental consideration; and the primary study cannot hope to do more than to indicate, for workers and other income receivers of various grades and classes, the amounts and purchasing power of their average incomes.

The reference just made to purchasing power brings up the first question in the interpretation of results. The world's very recent experience has shown only too well the lack of permanent significance in money incomes. The obvious and necessary step is to supplement each study of the national income with a careful determination of an appropriate price index. Since we are dealing with the incomes and expenditures of individuals, this must be primarily an index of retail prices; and, furthermore, since comparisons over long periods of time will be important, it may be desirable to use two indices, one based upon the prices of the fundamental necessities, and the other based upon an average of the items entering into the normal family budget at the time when the study is made.

A further important point of interpretation is that regarding direct taxes. Since governmental services, in the main, are not only necessary but also, in many cases, distinctly productive, it would be improper to deduct income and other direct taxes from the first summation and distribution of individual incomes. Nevertheless, the fact that a large proportion of direct taxes are based on ability to pay, rather than on the value of governmental services to the individual taxpayer, makes it necessary to set up a supplemental statement of the distribution of the national dividend after deducting direct tax payments. This will leave the balances that are really available for savings and for personal expenditures on commodities, and on services other than governmental services. Supplementing this adjustment there should, however, be certain estimates, in the reverse direction, of the tangible values of governmental services to various classes of income receivers. Instruction in the public schools is one of the most important of such services, and comparisons of real incomes made internationally, or between successive periods, would be quite misleading if this item should be neglected.

Still other necessary angles of interpretation appear in the consideration of the basic sources of income. It is particularly necessary, in these controversial days, to make clear separations between returns for personal service, rents of natural resources, and returns on capital

goods. The so-called "profits" of individual entrepreneurs are very frequently treated *in toto* as return on invested property, although on close analysis very large portions, if not the bulk, of such profits are found to represent only very modest returns for productive personal services rendered by the individuals involved. Some approximate separation of the entrepreneur's profits into these two elements should, therefore, be made. Similarly, it is very desirable to make at least an approximate determination of the total part of all individual incomes that is derived from the rents of land and other natural resources. This separation is not extremely difficult with regard to agricultural and residential property, but it is difficult with respect to land and other natural resources used by corporations and capitalized in their security issues.

It is not necessary to exhaust here the list of such possible interpretations and amplifications of the results of income studies. The examples given should be sufficient to indicate not only the need for such supplemental analyses, but also the practicability of establishing for them a reasonably definite and permanent procedure.

There is, however, one further special and very important point that must be mentioned—the economic meaning of additions to the surpluses of business enterprises and their position and proper treatment in studies of income and income distribution.

First of all, as to the nature of such surplus earnings, an initial subdivision may be made into the following elements:

a. Book profits based on revaluations of assets, etc.
b. Necessary, but unrecognized, insurance against contingencies and ultimate losses; *i. e.*, in the long run, a real expense of doing business.
c. Reinvestments in excess of the above, which never become the basis for dividends.
d. Reinvestments which sooner or later do become the basis for dividends.

The preceding separations tend to make clear the fact that additions to corporate surpluses cannot be treated *in toto* as returns to investors. The actual distribution of interest, profits, and dividends to individuals is the only tangible thing that can be dealt with. This tangible distribution may, of course, be affected in the future by present reinvestments, just as the present distribution is, to a considerable degree, affected by past reinvestments. Undistributed earnings may, in some cases, increase future dividend payments, although this increase will very rarely be as great as it would be if plant and business extensions had to be financed wholly out of new security issues. In other cases, they may tend to increase wages in the industries involved. But in the long run, it is probable that the principal tendency is to reduce prices of commodities and charges for corporate service This

is very certainly the case in connection with public utilities operating under close regulation.

Another viewpoint regarding undistributed business surpluses is that of their bearing on the distribution of the national product. It is rather easy to show, first of all, that they have no direct effect on the round flow of money or on the relative distribution of total money income between personal service, capital, and natural resources. The ten dollar bill that goes to a shoe factory for a pair of shoes will show up again as some person's individual income with equal certainty, whether it is spent wholly for shoe materials and the wages of shoe workers, or whether it is spent in part for the erection of additions to a shoe factory, or is taken by the government as excess profits taxes and spent for the support of government bureaus or the military establishment. In general, also, the way in which the money is spent will not greatly affect the percentages that finally appear as salaries and wages, dividends, etc. The only real result that develops from the existence of undistributed business earnings is, therefore, to hold title to a certain portion of the national product in suspense. It is not proper, however, to add the value of such suspense items to the money total of the national dividend. The actual operations are more nearly comparable to what occurs when the government imposes a sales or other indirect tax which is eventually reflected in commodity prices, and invests the proceeds in permanent buildings; although, in the case of surplus earnings in freely competitive industries, the source of the investment fund is not increased prices, but the withholding from investors of what may be described, rather elaborately, as the profits of supra-marginal efficiency of management and the rents of supra-marginal competitive advantage.

This analogy between land rents and the excess of the profits of non-marginal over those of marginal competitive concerns, has lately received considerable attention, and is the basis for much support given to excess profits taxes as a permanent source of governmental revenues. It may not, therefore, be out of place to conclude this paper with the suggestion that, as between governmental agencies and a large and growing number of public utility and industrial organizations, there is at least an even chance, both now and for the future, that equally effective and more direct social use may be made of surplus earnings if they are expended by the business enterprises rather than by the government. This is particularly true where business policies are in the direction of moderate rates of distribution of earnings, and the reinvestment of all balances in extended and improved productive plants, or other expansions of business activity.

THE CONDUCT OF THE FOURTEENTH CENSUS*

By WILLIAM M. STEUART, *Assistant Director of Census*

The debate in Congress attending the enactment of the law establishing a permanent census office, the discussions in statistical organizations, and newspaper and magazine articles are conclusive that the purpose of the law was (1) to advance and perfect the publications of the decennial census; (2) to assist in the elimination of the duplication in the statistical work of the various bureaus of the federal government.

We are now principally concerned with the first of these objects. A large force, approaching 100,000 supervisors, inspectors, clerks, agents, and enumerators, is suddenly turned loose on the country to collect important data concerning the inhabitants and their industries. The force is scattered over a vast territory with more complex social and industrial conditions than exist in any other country of the world. The period of employment is short, and the rate of pay is not attractive. No compensation can be allowed for preparatory work or study of instructions. Comparatively few of the persons engaged can come into personal contact with the administrative staff. The territory to be covered by each employee must be definitely described, and he must be familiar with it and with his instructions, so as to commence work on a fixed date. It is futile to expect such a force to be organized and fully equipped unless there is a well-organized staff and ample time is allowed for preparatory work. Naturally, the best organization cannot be secured unless the head of the Bureau has had some experience in the organization of a census. Otherwise, he cannot appreciate the relative importance of the various processes, or estimate the time at which they should be finished in order to begin other processes upon which the results depend. General Francis A. Walker was superintendent of the censuses of 1870 and 1880, but since then each census has had a different director. Some of the directors had had wide administrative experience but a very limited knowledge of statistics. Others were eminent statisticians but had had little administrative experience. It may be impossible to secure a man who has had proper experience in both fields. At any rate, service through at least one census is necessary to a proper conception of the work. Unless the head of the office has a clear vision of the magnitude and ramifications of a census, it

* Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

will be almost impossible for him to perfect an organization in advance of the work.

PREPARATORY WORK

Changes in the census law that always have been, and I suppose always will be, made prior to the taking of each census affect the scope and character of the inquiries and the general conduct of the work. The office is in ignorance of these changes until all the provisions of the law are finally decided. The law for the Fourteenth Census was not approved until March 3, 1919, and the census period commenced the following July. The appropriation for the work was not available until July 1, and, technically, no work could be done until after that date. There was, of course, an implied understanding that the permanent force of the office would or could be employed on the preliminary work for the decennial census in advance of the census period; but other duties were imposed upon the Bureau in connection with war activities and intercensal investigations that made it impossible to give proper attention to the preliminary organization for the decennial census. There was thus a constant pressure to postpone this organization. The result was that when the time for the actual enumeration arrived not all the enumeration districts had been established, some of the blanks had not been printed, and some had not even been drafted. An accurate description of each enumeration district is essential to the correct enumeration of the population. Changes are constantly being made in the boundaries of the political divisions and subdivisions of each state; and the enumeration districts must be so arranged as to harmonize with these political units and to make possible the preparation of a total for the population of each. I refer to this because it is one of the most important pieces of preliminary work required for a census. Its proper performance requires an extensive correspondence with local officials throughout the country, and considerable personal field work. I believe I am safe in saying that at no census has it been properly and satisfactorily concluded before the time for the enumerators to begin work. This condition is, without doubt owing to the lack of appreciation of its importance. The lack of definite and positive understanding concerning the boundaries of the enumerators' districts caused delay and more or less confusion in the offices of the supervisors and many errors by the enumerators. There are also many other things that should be done before the actual work begins that never have been done.

CHANGES IN CENSUS LAWS

The law governing the Fourteenth Census differs in many respects from that providing for the Thirteenth Census. There are at least

five changes and groups of changes that seriously affect the work: (1) The provision for a census of Guam, Samoa, and the Panama Canal Zone; (2) the appointment of supervisors by the Secretary of Commerce upon the recommendation of the Director of the Census; (3) the advance of the date of the enumeration from April 15 to January 1; (4) provision for the amplification of the irrigation inquiry and for the enumeration of drainage projects; and (5) changes in the population and agricultural inquiries.

Aside from the law, the scope of the census and the organization decided upon by the Director were dissimilar in some important respects to the corresponding features of the Thirteenth Census. The appointment of the supervisors by the Secretary was an improvement over the method employed at preceding censuses. If the law had been enacted a year earlier, a much more satisfactory organization would have been possible. The accuracy of the entire census of population and agriculture depends upon the efficiency of the supervisors. Their temporary employment is the survival of the former custom of creating a temporary organization for each census. Some time I hope the practice will be abolished, and the work done by the regular trained employees of the Bureau. Such an arrangement will not only reduce the expense, but will greatly reduce the margin of error and advance the completion of the enumeration. Two districts, Porto Rico and Hawaii, were supervised, and the work in three or four others was completed, by the regular employees. In other cases it was necessary to station one or more of the regular census force in the office of the supervisor to insure a satisfactory enumeration. The position of supervisor is so temporary that the person appointed cannot, or in the majority of cases does not, give up his other employment. The census work, therefore, is secondary, and does not receive proper attention. It is needless to give examples of indifferent work on the part of supervisors. To have this, the most important piece of census work, done by temporary employees who have had no prior experience and who know nothing of census taking, is, to say the least, very poor administration.

The change in the date of the enumeration was made at the request of the Department of Agriculture, and also because it was contended that more people would be found at their usual places of abode in January than in April. I agree that if the enumerator is able to see the farmer in January he is more likely to get correct data concerning the operations of the farm during the preceding year than he would be from an interview in the following April. But the enumeration of the population is the principal object of the census, and the experience

at this census has convinced me that a more nearly perfect and a more rapid count of the people can be made in April than in January. It is true that during April and June, when the enumeration has heretofore been in progress, large numbers have been at summer resorts. But at this enumeration it was found that surprisingly large numbers were at winter resorts. Thousands who have their usual places of residence in the northern states spend the winter months in southern California, Florida, and other southern states. Some of them live in the south several months of each year, and it was difficult to determine their usual places of abode. In this respect the change complicated the work; certainly it did not simplify it.

The weather in the winter is a serious impediment to the work of the enumerators, especially in the rural districts, and it is probable that the change in the date increased the margin of error caused by defective enumeration.

THE CENSUS SCHEDULES

But few persons realize the importance of care in the wording of the census schedules. The Fourteenth Census covers population, with special schedules for the blind and deaf; agriculture, with a special schedule for animals in barns and inclosures not on farms; manufactures (including forest products), with 85 supplemental schedules; mining, with 44 supplementals; irrigation; and drainage. There are in all 138 schedules upon which data required for some branch of the census must be reported. There are hundreds of inquiries to be answered—not all by every individual, but some by all individuals. Each director, from General Walker down, has called attention to the necessity of simplifying and reducing the number of census inquiries, and has referred to the overburdening of the enumerators and the impossibility of obtaining correct replies to all the inquiries in the short time allowed for the work. Yet there is constant pressure to extend the census inquiries and to reduce the time allowed for the field work, so that the more complicated office work can be completed within the census period. The practice of relieving the enumerators of the schedules for manufactures, mining, irrigation, and drainage that has developed during recent censuses has tended to reduce their work, but at the same time the other schedules have been extended. The instructions to enumerators fill a pamphlet of more than 50 pages. It is unreasonable to expect men or women appointed for such temporary work at such low rates of compensation to take time even to read through such extended schedules and instructions. The applicants were required to prepare a formal application, to take a practical test,

and attend schools of instruction; but there were more than 86,000 enumerators to be instructed, and the instructions were necessarily more or less superficial. I, personally, instructed some classes, and could not do more than touch on the most important features.

We are now making every effort to compile a reasonably accurate census and to publish the results within the time required by the law. But our population and industries are increasing rapidly, and it will be impossible at subsequent censuses to do the work as now outlined. The number of inquiries must be reduced or the time extended. Mr. Durand, director of the Thirteenth Census, in a memorandum left for assistance at subsequent censuses, states that it is of the utmost importance to the success of a census that the schedules should be simplified to the last possible degree consistent with obtaining fundamentally essential information.

It is not an easy task to omit inquiries. The law directs that certain subjects shall be covered, and pressure is constantly being made to extend the scope of these inquiries and to add new ones. The files of the office are full of correspondence and reports of committees on the subject. To illustrate: There is no very clear authority of law for making an enumeration of poultry, either on farms and ranges or not on farms and ranges. The wording of the law of 1910 was that the schedules relating to agriculture shall include "number and value of live stock on farms and ranges; number and value of domestic animals not on farms and ranges." The Department of Agriculture has construed the words "live stock" to include poultry, and as the law specified "domestic animals" not on farms to be reported, poultry was omitted in 1910 from the schedule for barns and inclosures not on farms. In the law for 1920 the words "domestic animals" were omitted and the words "live stock" substituted. To one not acquainted with the technique of census work this appeared to be a perfectly harmless change, but it was presumably made on the supposition that an inquiry in regard to poultry raised in cities would or could be added to the schedule to be applied to barns and inclosures not on farms. Such an inquiry would increase the cost of the field work by about $50,000 and add a proportional amount to the cost of the office work; in addition, it would increase the burden on the enumerators.

Important as the other inquiries may be, the reputation of the Census Bureau depends upon the speedy and correct announcement of the population. The population schedule for 1910 contained 34 columns, and for 1920, 29. The inquiries omitted were "Number of years of present marriage"; "Number born," and "Number now living," for children of each mother; "Whether out of work on April

15, 1910"; "Number of weeks out of work during year 1909"; whether the place reported was a "Farm or house"; "Whether a survivor of the Union or Confederate Army or Navy"; "Whether blind (both eyes)"; and "Whether deaf and dumb." At the present census the last two inquiries were covered by a supplemental schedule on which the enumerator recorded the name and address of each blind or deaf person. Thus there was apparently an elimination of nine inquiries from the 1910 schedule, two of which, however, were carried in different form on a supplemental schedule. On the other hand, the 1920 schedule contains four new inquiries, one of which relates to year of naturalization and the other three to mother tongue. Strictly speaking, however, the mother-tongue inquiry is not a new one, because, although the schedule for 1910 did not make any provision for it, the enumerators were instructed to report the mother tongue in the column calling for place of birth. This method was not satisfactory, and on the 1920 schedule separate columns were provided for mother tongue. Thus the actual net changes consisted in the dropping of seven inquiries and the addition of one.

The mother-tongue inquiry was technical and required great care to secure correct answers. The records of the Bureau contain the following recommendation by Director Durand concerning this inquiry:

"Another inquiry which it is probably desirable to eliminate is that with respect to mother tongue, except for persons born in a few foreign countries where there is a great mixture of population. This inquiry, which was considered the best available guide for determining racial stock, was provided for by an amendment to the census act, passed only a very short time before the enumeration. It was recommended by the Director of the Census, partly on account of the scientific value of the information, but more because of the insistent demand of the leading representatives of the races coming from Austria-Hungary. There is no question that the information would be of much scientific value if it could be obtained with accuracy and without unduly burdening the enumerator. Save with respect to a few countries, however, the return of country of birth itself is a very close guide to the racial stock of the people, and the additional information secured by the mother-tongue inquiry is not worth the trouble and expense it causes. For instance, persons reported as born in Italy are so nearly all Italians that there is practically nothing gained by distinguishing the few who may by chance have other mother tongues. The same is true of England, Scotland, Wales, and Ireland, of the Scandinavian countries, of Spain, and, in fact, of the larger part of the countries of the world.

"On the other hand, it is well known that there is a remarkable mixture of different races and mother tongues in Austria-Hungary, Germany, and Russia, and that in Canada there is a wide difference between the French-speaking and the English-speaking population. For example, to report the characteristics of persons coming from Austria-Hungary, without distinctions of race, is decidedly unsatisfactory, because of the wide difference in characteristics between the Germans, Poles, Bohemians, Magyars, and other races of that country. Both for scientific reasons and in order to meet the wishes of the people who have come to the United States from the

four countries above mentioned, it is undoubtedly desirable to retain the inquiry of mother tongue regarding them. The elimination of the inquiry with respect to persons born in other foreign countries would, however, very materially reduce the labor of the enumerators, without in any serious degree reducing the value of the returns."

The instructions to enumerators for 1920 contain a list of 63 principal languages, and the enumerators are expected to report many others.

Of all the inquiries those relating to the place of birth and mother tongue of the parents and to occupations were the most difficult to answer. A large proportion of the census reports are based on information obtained from the housewife. In many cases the wife was not certain about the country of birth of her husband's father and mother, and there was a much greater uncertainty when the answers were given by a third party, as was frequently the case. This lack of knowledge coupled with the changes in the boundaries of European countries following the war has, I am afraid, caused a large margin of error in the statistics on this subject. The increase in the number of defective reports is largely confined to the immigrants from the central and southern European countries.

Although a detailed analysis of the foreign element of the population is very important, we are certainly trying to gather too much information through the general enumeration. In view of the imperative necessity of reducing the number of inquiries, we should certainly be justified in confining the questions to the birthplace and mother tongue of the person reported.

Some of the inquiries are apparently very simple and easily answered, but in reality they require the exercise of considerable discretion and a personal conference with the individual enumerated. The one on "Color or race" is a good example. To answer this the enumerator must determine not only whether the person is black or white, but whether he is a mulatto. There are cases in which the same family has been enumerated as black at one census and as mulatto at a subsequent census. The enumerator must further determine whether the person is an Indian, Chinese, Japanese, Filipino, Hindu, Korean, or "all other," and insert the proper symbol. Sometimes it is difficult to decide the nationality even after a personal inspection. In Charles City County, Virginia, there is a community of several hundred, remnants of the original tribe of Chickahominy Indians. The Indian strain is considerably diluted and the language is practically lost; nevertheless they contend that they should be reported as Indians. Other citizens of the county, however, declare that they are not Indians and should be reported as Negroes. Some of these men came to the office in Washington for the purpose of urging that all members of the so-called tribe be enumerated

as Indians. Those that we saw certainly had pronounced Indian features; but the enumerators decided that not all of the tribe should be reported as Indians, and I imagine that no one can say just where the line of distinction was placed.

If the census were confined to a simple enumeration of the population with very limited information concerning its characteristics, the instructions to enumerators would be greatly reduced. It would then be much easier to obtain enumerators at the rates of pay the government is willing to offer.

There are many who look in holy horror at the suggestion to omit the inquiry concerning occupations. Since 1910 there has been a great amount of work done in the endeavor to perfect the census of occupations. Exhaustive lists of occupations have been prepared and the instructions for enumerators and for the office work carefully revised. The editing and tabulation have been made a distinctive feature and not carried on as a part of the individual census as heretofore. The editing of the schedules was started as rapidly as they could be released from the general population work. By November 15 there were 259 clerks engaged in the examination and the insertion of the symbols for the occupation punch cards. This force had been gradually and carefully built up, and we are in hopes that the statistics will be a more accurate presentation of our occupations than the office has been able to compile at any preceding census. The defects in the work, however, are fundamental. As in the case of the mother tongue, mistakes are made by the enumerators or by the persons who answer the inquiries. The returns for 1910 were bad enough, but it is my impression that those for 1920 were, in certain particulars, even more defective.

I fully appreciate the importance of statistics of mother tongue and occupations. At the same time, the population and industries of this country are growing at a constantly increasing rate. Industries are becoming more complex. The increase of 13,710,842 in our population that occurred during the past decade is necessarily accompanied by some corresponding ratio of increase in the agricultural, manufacturing, and other activities of the people. The time is rapidly approaching, if it is not now at hand, when there must be some radical changes made in our census methods. The suggestions that the time allowed for the work be indefinitely extended, that the pay of the supervisors and enumerators be materially increased, that more time and care be devoted to preparatory work, etc., are all good. They would probably result in a more scientific and instructive analysis of the data. But these changes would not enable the Bureau to meet the insistent demand for the publication of the results of the census shortly after the date to which they relate.

ANNOUNCEMENT OF POPULATION

It is impossible to give an explanation, satisfactory to the general public, of the reasons why the population of the United States cannot be announced until almost ten months after the date to which the figures relate; or why there is such a delay in the announcement of the totals for agriculture and manufactures. It is, or will shortly be, impossible to throw the census net over the entire population and all of their activities, bring the different corners into Washington, and there compile and announce the results as quickly as is desired. It will be necessary to subdivide and distribute the work. For example, the preliminary count of the population for which the total for the United States was published on October 7 was based on the count made by the supervisors, verified by a hand count in the office at Washington. The supervisor must count the number of individuals returned by each enumerator and state the total on the enumerator's pay voucher and also on a check slip accompanying his returns. When these reports reach the Washington office a rapid count is made by glancing over each sheet of the returns, and if the two counts agree, the total is accepted. With proper safeguards the totals could be assembled and made public by the supervisors before the work was sent to Washington. They would, of course, be preliminary and subject to revision, just as they are now. The method would have the great advantage of quick announcement, and would enable the supervisors to answer and dispose promptly of all criticisms of defective enumeration. Under the present method it is impossible in many cases to make an accurate check of the enumeration and to correct errors, if errors are found, because there are so many changes between the time of the count and the date of announcement.

The greatest reductions in the number of inquiries should be made in the schedules for agriculture and manufactures. Details on these subjects can be developed at the mid-decennial censuses and for manufactured products at the biennial enumerations. The entire omission of manufactures, and, if practicable, of agriculture also, from the decennial census would be an improvement. It would certainly enable greater accuracy and more rapid work in the enumeration of the population.

The principal processes involved in the taking of a census are the establishment by metes and bounds of the supervisors' and enumerators' districts (378 and 87,234 in number, respectively, at the Fourteenth Census); preparation of schedules and instructions; selection, appointment, and instruction of supervisors; selection, appointment, and instruction of enumerators and inspectors; distribution of blanks;

conduct of the enumeration; shipment of completed schedules to Washington; preliminary examination of schedules to see if all are received, and if there is any evidence of padding or irregularities; preliminary count of population; announcement of preliminary totals of population; disposition of requests for re-enumeration; editing schedules, or their preparation for the card-punching machines; punching the cards, verification of cards by machine and by personal inspection; verification of cards rejected by the machines; comparison of machine count with hand preliminary count; assortment of cards for machine tabulation; various runs of cards through tabulating machines; editing schedules for census of occupations; punching cards for occupations; machine tabulation of cards for occupations; preparation of final tables for printer.

USE OF MACHINERY

At this census machinery, both hand and power driven, is being used more extensively than at any preceding enumeration. It is employed in all three of the principal branches—population, agriculture, and manufactures. Necessarily, the processes differ in each branch; but they all are based on the same general principles.

The machines are not perfect or entirely satisfactory for census work. The punch used for the population card is the most unsatisfactory. The tabulating machine was developed in the Bureau, and is far in advance of any heretofore used. The commercial punch used in the work on agriculture and manufactures is not satisfactory because of the small number of items carried on each card. It requires 17 cards to carry all the items necessary to be punched from the agricultural schedule, and one for the live-stock schedule, thus increasing the number of cards to about 167,000,000.

This is the first time the card system has been used in the work on manufactures. Undoubtedly it will enable a more detailed presentation, but whether it will be as economical and lead to as early a publication as the systems used at prior censuses is questionable. The demand for more and more detail concerning the various products of manufacture has resulted in greatly extending the schedules. It has also encouraged the chief statistician in charge of the work to expand and indulge in a more elaborate presentation. I think this is a mistake. At the decennial periods the census of manufactures, if taken at all, should be greatly curtailed. It should, at least, be confined to the general schedule, and all supplemental special schedules omitted.

If the census of mines is taken in connection with that of manufactures, the line of demarcation should be more clearly defined than it

was at preceding censuses. The separation of the statistics of manufactures and mining is complicated by the work of the Geological Survey. The Survey makes annually a census of mineral production, and, naturally, we should expect its totals for the decennial census years to agree with those compiled by the Bureau of the Census. This is especially true if the two bureaus work in coöperation, as they have at the past two or three censuses. The Survey, however, very properly includes in its total many products which are primarily the result of manufacturing processes and which are included in the census of manufactures. At the census of 1910 they were also included in the census of mines. In other words, there never has been a clear-cut distinction in the census between manufacturing and mining. I do not know that there is a practical line of separation that can be uniformly applied, but I do believe it is possible to devise a more satisfactory method than the one used at the census of 1910.

CHANGES IN PROCEDURE

Many changes were made in the order of procedure at this census as compared with prior censuses. The most important of these was the publication of the figures for the minor civil divisions of each county as quickly as they were ascertained. These figures were used to build up the state totals, which were then announced. In 1910 the county and state totals and those for cities having 5,000 or more inhabitants were announced, but no chance was given the public to criticise the figures for the smaller divisions. The change enabled us to give these figures to the persons interested and to receive their criticism in time to correct errors and make minor adjustments. Many complaints of defective enumeration were received. A few were well founded; in such cases the enumeration was checked and the corrected totals carried into the printed reports. In 1910 the office did not have the advantage of this advance criticism; the totals were, as a rule, published as final. It was too late to make changes in the figures for the minor divisions, and very little checking of the enumeration was done.

MARGIN OF ERROR

Most of the error in census reports is due to defective field work. The office is constantly endeavoring to reduce this margin of error by improving the instructions to enumerators and agents, and by a closer supervision of the field force. The error with respect to the number of inhabitants, number of farms, number of manufacturing establishments, etc., is comparatively small. It increases in the replies to the

various inquiries on the different schedules. I believe that the greatest amount of error occurs in the replies to what are considered essential and well-constructed inquiries, but that relate to matters concerning which it is difficult for the enumerators to obtain information. The percentage of error increases with the difficulties encountered by the enumerators as well as with the number of questions. Practical experience in census taking is very helpful in the construction of schedules, and a wise discrimination in the selection of inquiries is essential to the success of the work.

The population of the United States was announced on October 7. This was twelve days later, relatively, than it was made public at the Thirteenth Census. This delay was owing to a change in methods which has resulted in a great deal of work being done before, which at the last census was done after, the announcement but before the publication of the bulletins. On October 7 the work was in far better shape to proceed with the publication of bulletins on population than it was at the corresponding date ten years ago.

CENSUS ADVISORY COMMITTEE

At this census the Bureau has had the privilege of conferring frequently with a committee composed of members of the American Statistical and American Economic Associations, and the advantage of their advice on all important matters. The committee has been consulted at every important stage of the work, and its recommendations have been almost uniformly followed. The committee has considered all the basic tables and many of the subsidiary ones. It has been mutually agreed that the text of the bulletins and reports shall be confined to the brief description of the tables, and that some of the tables contained in the reports of the Thirteenth Census shall be omitted from the Fourteenth Census, and many changes made in others. We shall retain all that is essential, and shall endeavor to put it in more logical form and to reduce the size of the reports. The state bulletins on population and agriculture that have been printed and distributed illustrate the character of the changes that have been made. For example, the bulletin for 1910 giving the number of inhabitants, by counties and minor civil divisions, for Massachusetts contained thirteen printed pages. The corresponding bulletin for 1920 has nine pages, and yet we believe it contains more essential statistics. There were two bulletins on agriculture for each state at the last census. At this census there will be but one.

A free discussion of policies and methods with trained men not in the federal service but who make constant use of government statistics

cannot but be helpful to the service, and I hope the committee will be continued until the end of the census period.

PUBLICATIONS

The preliminary totals for the population of all states, counties, cities, and minor civil divisions had been published on or before October 7. There are a number of factors that may be compared in order to determine the relative progress of the work at the different censuses; the rapidity with which copy for the final reports is sent to the printer is the most definite. At the census of 1910 copy for the first bulletin, giving statistics of population by minor civil divisions for New Jersey, was sent to the printer just 10 months and 25 days after the beginning of the enumeration. The first bulletin of this character sent to the printer at the Fourteenth Census was for Porto Rico, and it was sent to the printer just 4 months after the beginning of the enumeration. Within 11 months and 5 days after the beginning of the enumeration at this census we had sent to the printer copy for these bulletins for 31 states, Porto Rico, Hawaii, Guam, and Samoa, making a total of 35 bulletins. At the preceding census copy for only 2 bulletins was sent to the printer within 13 months and 14 days. By December 31, 1921, copy for the last minor civil division bulletin was sent to the printer, just one year after the beginning of the enumeration, which compares with 1 year, 6 months, and 22 days for the last Thirteenth Census bulletin of this character. For agriculture, copy for bulletins on 10 states has been sent to the printer, while none had been sent to the printer at the corresponding date of the Thirteenth Census. The tables for the second series of bulletins—those on the composition and characteristics of the population—have been established, and we shall soon begin to send copy to the printer for the different states. These bulletins will complete the reports in which the state is the primary unit. The final volumes on population will contain further details for certain subjects, such as race, nativity, age, marital condition. In these the classification is based on the subject, and the states, cities, and counties are subsidiary. In like manner the report on agriculture will contain special reports on race, nativity, and tenure of farmers, on live stock, selected crops, etc. Two series of reports will be published for manufactures, one by states and the other for selected industries.

CONCLUSIONS

The work has hardly proceeded far enough to enable us to say definitely how it will compare with preceding censuses in accuracy, dispatch, and cost, but the stages that have been completed, I believe, justify the following conclusions:

1. Either the period fixed by law for the completion of the census must be extended or the scope of the work greatly curtailed.
2. It was a mistake to advance the date of enumeration from April 15 to January 1.
3. Greater care should be taken to perfect the preliminary work.
4. The enumerators' districts should be finally and definitely described and established sufficiently in advance of the appointments to insure a proper understanding of the boundaries.
5. All schedules and instructions should be greatly reduced.
6. Manufactures and mining should be omitted from the decennial census or the inquiry limited to the number of persons engaged and the production; this on the understanding that there will be a complete census of manufactures at regular intervals during the intercensal periods.
7. Supervisors should be trained employees and not temporary appointees.
8. The preliminary count of the population for counties, cities, and minor civil divisions should be made in the offices of the supervisors and announced by the supervisors.

By the establishment of a permanent census office almost twenty years ago, the federal government definitely committed itself to a permanent program for census work. It has failed, however, to place in the Bureau the authority to establish a satisfactory organization, and to provide for the elimination of duplication in work of a similar character being carried on by other federal bureaus. These bureaus are constantly coming in contact over questions that never can be satisfactorily settled until the collection of statistics is centralized and a radically different scheme of organization established.

The Department of Agriculture collects data and compiles estimates pertaining to questions covered by the decennial and intercensal inquiries of the Census Bureau. Frequently the results of the census are not entirely satisfactory to the officials of the Department of Agriculture, and it endeavors to verify or establish the margin of error in census reports.

The United States Geological Survey makes an annual census of the production of minerals, and collects other statistics concerning our mineral industries. This comes in contact with our decennial census of mining.

The Bureau of Internal Revenue compiles statistics of the consumption and stocks of tobacco, which come in contact with those compiled by the Bureau of the Census.

Still other examples could be given of the lack of coördination in the statistical work of the bureaus. This condition, and the need of a better organization, covering the entire United States, looking to the collection of data concerning the population, resources, and industries of the country, lead to the conclusion that some scheme should be worked out for the appointment of local representatives in different

states or sections of states who would attend to all statistical work required by the federal government. Such an organization, if properly formed and placed under the supervision of one bureau, would go far toward eliminating the unsatisfactory features of the present system or lack of system. I believe that some scheme of this character was in the mind of Congress when it established the permanent Census Bureau, and I am in hopes that it will again be revived and carried into effect.

INDUSTRIAL ESTABLISHMENT DISABILITY RECORDS AS A SOURCE OF MORBIDITY STATISTICS*†

By Edgar Sydenstricker and Dean K. Brundage, *United States Public Health Service*

Epidemiology is yet an undeveloped science largely because it lacks the basic data which it must draw from the field of vital statistics. Clinical medicine and bacteriology have made available a large body of material for its use, but since the epidemiological method is essentially the statistical method and epidemiological data are chiefly statistical data, the growth of this new branch of knowledge has so far been one-sided. We cannot hope for its uniform development until accurate and complete statistics of disease incidence in different population groups and under varying conditions of environment are collected currently and in considerable detail.

The statistics of disease incidence which are now available are confined almost entirely to deaths. The grave shortcomings of mortality data as the basic data for statistical research in disease incidence have not, perhaps, been sufficiently realized. In fact, the statement may be ventured that we have been too satisfied with and have attached too much importance to epidemiological conclusions based upon data which relate to only one phase of disease incidence. We are yet greatly in the dark with regard to even the most important facts concerning predisposition to disease, the conditions under which disease begins, and the circumstances which affect or control its course in a population. What we need, what we must have, before satisfactory progress can be made, are morbidity data.

This has been said so often that it has become trite. May it not be said that we have fallen more or less into the habit of regarding complete and accurate morbidity statistics as an impracticable ideal, as a goal impossible of attainment? Is there not in such an attitude this element of danger—a tendency to relax in the endeavor to obtain the desired data simply because they cannot be obtained at once and with the methods which we are accustomed to use in recording mortality?

Before bringing to your attention a possible field for morbidity research, a brief consideration of the situation with regard to morbidity statistics seems pertinent.

The data upon which morbidity statistics are now based necessarily are less uniform, less complete, and less accurate than those which are

* From the Statistical Office, United States Public Health Service.

† Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

the foundation of mortality statistics. A death is an event of which the local public, in the performance of certain governmental functions and in the observance of certain social conventions, must take cognizance. The fact that a citizen has ceased to live is usually recorded: at least, some statement of the cause of his demise is placed upon the public books, and certain facts as to his nativity, sex, age, marital condition, residence, occupation, and the like are ascertained. His remains cannot be disposed of until these things are done. We have, therefore, a set of mortality records which are gradually becoming more uniform, more complete, and more accurate. An illness, on the other hand, is a commonplace happening unless the affected individual is regarded as a menace to the community. A case of leprosy, of typhus fever, of bubonic plague, or even of smallpox or scarlet fever, is important enough in the public mind as a source of danger to be reported and isolated. But a disability resulting from tuberculosis or from a non-communicable disease equally as serious to the individual and, indirectly, to the community is such an every-day affair that only by the most searching inquiry can its occurrence be ascertained and recorded.

The obstacles actually encountered in obtaining morbidity reports for a given population or population groups are well known to vital statisticians. The chief difficulties may be expressed in three statements:

(1) Only such diseases can be reported as come to the attention of physicians and other diagnosticians. These diseases ordinarily are brought to their attention only at a stage when discomfort, pain, or disability is experienced; in their incipient and latent stages, when they are not noticed even by the individual affected or do not interfere with his normal activities, but when their importance is equally as great or even greater, they are not reported.

(2) Only such cases are reported as are (a) notifiable under the law, and of these (b) only the ones that the physician or other reporting agency is willing to report.

(3) Even when the occurrence of an illness is reported, the diagnosis is frequently less accurate than a statement of cause of death. This is inevitably so for the reasons that the illness itself may be merely a symptom of one or several diseases, that it is not always practicable to apply established tests, and that the individual affected cannot be under sufficiently close observation to obtain the necessary clinical evidence.

How, then, are we ever to obtain the necessary material for statistical analysis or epidemiological research?

Let us examine, for a moment, the possible sources of morbidity data. Keeping in mind the fact that the occurrence of disease in a population for which certain facts as to race, sex, age, and various environmental conditions can be known, is the goal, we may classify the various sources into three general groups, as follows:

1. Reports of diseases that are "notifiable" under law, which are made by physicians and other diagnosticians to health authorities.

2. Disability or sickness records for persons associated into insured groups, for persons employed in certain industrial establishments maintaining fairly detailed supervision of the health of their employees, for persons living in various institutions, and in the armed forces of the United States.

3. Special surveys of observed groups of persons that are made with the specific purpose of obtaining accurate records of the incidence of a given disease. These studies are, of course, researches in their purpose and character.

It will be seen at once that the first source of material mentioned—the reports of certain notifiable diseases which have accumulated in every health department—does not begin to satisfy the elementary requirements for statistics of disease incidence. The reports are by no means complete for any disease, even assuming the diagnosis to be trustworthy. They do not contain accurate or sufficient data regarding conditions under which the disease occurs. The decennial enumeration of the population as to specific occupation, for example, cannot be utilized, and the cases are not reported for any definitely enumerated population from any point of view. The third source of material obviously is of a special kind, and its scope and its usefulness are limited only by the amount of money and time spent and by the ability of those who are making the research. The second group of sources of data, on the other hand, afford at the present time more encouragement of a practical sort for obtaining *current* facts as to disease incidence for a definitely known exposure under a limited number of important conditions than either health department records or the results of special surveys.

In this belief, the attempt is being made by the statistical office of the Public Health Service to collect current records of disability (exclusive of those due to industrial accidents) occurring among employees of industrial establishments. The project was planned with the assistance of a committee of the American Public Health Association.*

* The plan for standardized sickness records and reports is contained in the following Public Health Reports:

1. *Report of Committee on Industrial Morbidity Statistics*, Reprint No. 484.
2. *Continuation Report of the Committee on Industrial Morbidity Statistics*, Reprint No. 564.
3. *Sickness Records for Industrial Establishments*, Reprint No. 573.
4. *Diseases Prevalent among Steel Workers in a Pennsylvania City*, Issue of December 31, 1920.

Since very few plants maintain records of specific causes of disability among their employees, it was necessary to utilize records of such sick-benefit associations of employees as were willing to conform to a standard system of records and reports. These records show for each case of disability the date on which cash "benefits" commenced (usually the third, fifth, or seventh day of disability), the number of days for which benefits were paid, and the cause of disability as stated on a physician's certificate. At the present time, about sixty such associations are coöperating with the Public Health Service, although not all of them have made the changes in their method of recording and reporting disabilities that are necessary to conform to either of the "standard" methods suggested by the committee and the Public Health Service. The total membership of these associations at last report was approximately 250,000; because of reductions in force, this "exposure" will probably be considerably decreased. Two standard methods of recording and reporting disabilities were proposed to industrial establishments and sick-benefit associations in order to secure their sickness experience as well as to assist them in utilizing and analyzing their own records as a basis for preventive work. (1) One method requires a record of the number of persons considered by sex and occupation (or department within the plant), and a record of every case of disability for which sick benefits are paid, showing the date of onset (*i. e.*, the date on which disability commenced), duration (*i. e.*, the number of days for which sick benefits were paid), diagnosis, and occupation (or department) in which the disabled person is employed. (2) The other plan includes not only the data required in (1) but also contemplates a greater amount of detailed information, such as the age, race, length of time in occupation, etc., for both the persons considered and the cases of disability among such persons. The latter plan requires a rather detailed system of individual cards and only a few plants are at present in a position to put it into effect.

Although the work of utilizing these records, after placing them on either of the so-called standard plans, is still in an experimental stage and the policy of retrenching as much as possible on all expenditures for records is being practiced in industrial plants generally at the present time, it is believed that the use of such records can be developed to serve two important purposes: (1) to furnish fairly current information regarding the incidence of disease among a representative group of wage-earners in different industries, and (2) to accumulate a mass of data relating to the causes of disability among a large number of adult persons of different race, sex, age, and occupation and industry.

Since the plan has been inaugurated only a few months, the material

so far collected is not sufficient to warrant definite conclusions on any of the essential points. The data cannot be presented here in detail, but for purposes of illustration we will call attention to two tabulations. One shows the monthly variation in diseases which caused disabilities of seven days or longer in a group of plants during the first eight months of 1920; the other shows the incidence of various diseases causing a disability of more than one day during a 12-month period in a large industrial plant.

Taking up first the monthly variations in disease incidence among the members of certain sick-benefit associations of employees in a group of industrial establishments: The number of persons considered varied from 14,208 in January to 62,757 in July, and the number of industrial establishments from 8 in January to 25 in July. The annual incidence rates per 1,000 persons for sicknesses causing inability to work for seven days or longer by months were as follows: January 275, February 327, March 126, April 103, May 77, June 67, July 67, August 54. An extremely wide seasonal variation thus is manifested, the rate for February being approximately six times the rate for August. It will be recalled that the recrudescence of epidemic influenza occurred in the first three months of 1920, particularly in February, and in order to find out to what extent the epidemic influenced the seasonal variation in disease incidence, the following table and graph were prepared, showing the monthly incidence rates of influenza and grippe in comparison with the rates for the principal disease groups. Cases diagnosed either as influenza or as grippe were combined, because the terms were often used interchangeably in reporting the epidemic.

In the first two months of the year the frequency rate for influenza and grippe, it is seen, was larger than the frequency rate for all other diseases combined; in March, however, the number of new cases of influenza and grippe dropped perceptibly below the rate for all other diseases, and gradually diminished to the negligible incidence of 0.8 cases per 1,000 in July. The occurrence of the epidemic in the months in which sickness ordinarily is heavy accentuated markedly the usual seasonal variation. Even with influenza and grippe eliminated from the sickness rates, disease occurrence was about twice as frequent in winter as in summer.*

When influenza and grippe are subtracted, there still remains a surprisingly high frequency rate of sickness causing disabilities of seven days or longer. In January this rate was 132 new cases per 1,000 persons on an annual basis, and even in August, the month of lowest

* In regard to the more important diseases and groups of diseases occurring each month, it should be stated that the monthly fluctuations in their incidence, presently to be discussed, were indicated in a general way for each reporting association.

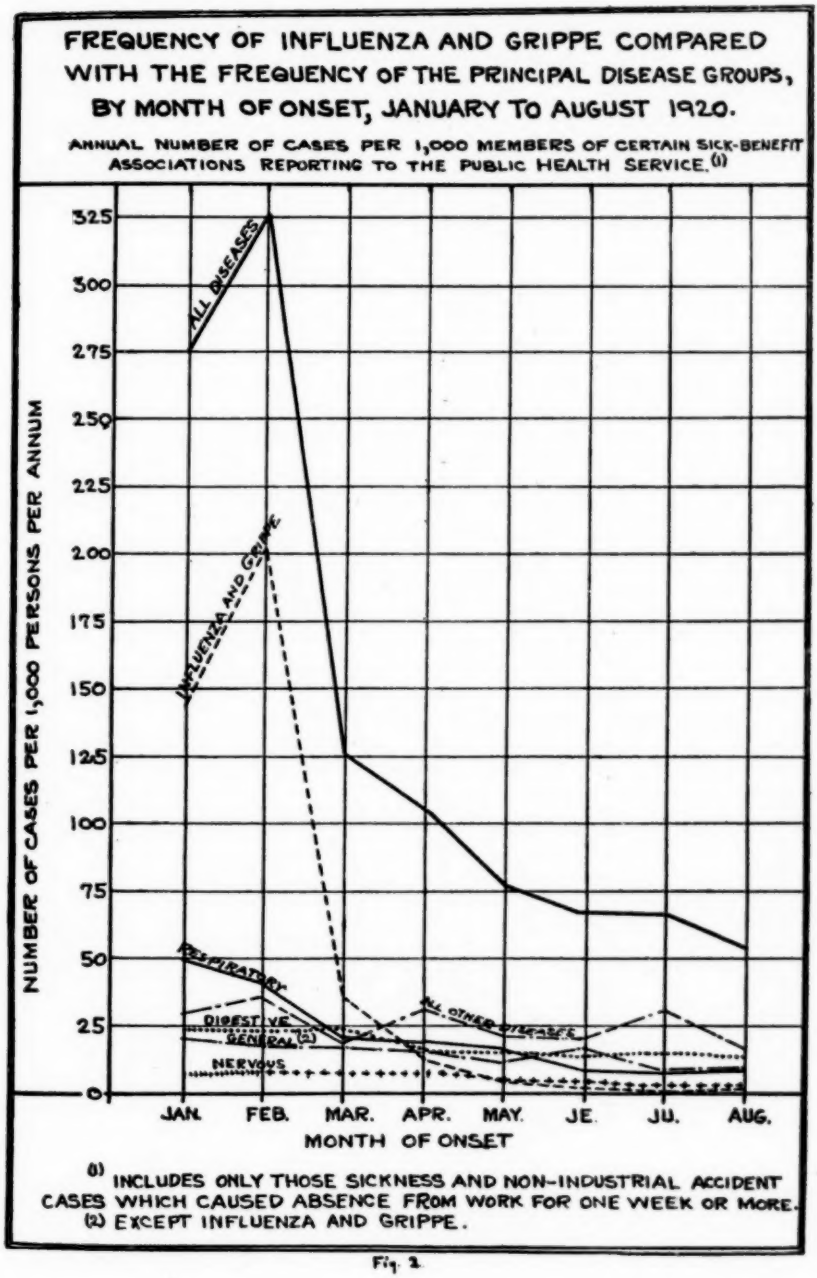

FREQUENCY OF INFLUENZA AND GRIPPE COMPARED WITH THE FREQUENCY OF THE PRINCIPAL DISEASE GROUPS, BY MONTH OF ONSET, JANUARY TO AUGUST 1920.
ANNUAL NUMBER OF CASES PER 1,000 MEMBERS OF CERTAIN SICK-BENEFIT ASSOCIATIONS REPORTING TO THE PUBLIC HEALTH SERVICE.(1)
NUMBER OF CASES PER 1,000 PERSONS PER ANNUM
325
300
275
250
225
200
175
150
125
100
75
50
25
0
ALL DISEASES
INFLUENZA AND GRIPPE
RESPIRATORY
DIGESTIVE
GENERAL (2)
NERVOUS
ALL OTHER DISEASES
JAN.
FEB.
MAR.
APR.
MAY.
JE.
JU.
AUG.
MONTH OF ONSET
(1) INCLUDES ONLY THOSE SICKNESS AND NON-INDUSTRIAL ACCIDENT CASES WHICH CAUSED ABSENCE FROM WORK FOR ONE WEEK OR MORE.
(2) EXCEPT INFLUENZA AND GRIPPE.

Fig. 2.

TABLE I

FREQUENCY OF INFLUENZA AND GRIPPE COMPARED WITH THE FREQUENCY OF THE PRINCIPAL DISEASE GROUPS, BY MONTH OF ONSET, JANUARY TO AUGUST, 1920*

Month of onset	Number of associations reporting	Membership	Number of cases per 1,000 persons per year							
			All diseases and conditions	Influenza and grippe	Other diseases and conditions					
					Total	Diseases of respiratory system	Diseases of digestive system	General diseases†	Diseases of the nervous system	All other diseases
January	8	14,208	275.0	142.9	132.1	49.9	24.1	20.8	7.5	29.8
February	13	22,249	326.7	201.4	125.3	40.8	22.7	17.5	8.5	35.8
March	14	23,527	126.0	37.1	88.9	21.1	24.1	17.1	8.0	18.6
April	18	30,075	103.4	13.2	90.2	19.4	15.6	16.6	8.0	30.6
May	22	58,302	76.7	4.6	72.1	16.8	15.3	12.2	5.9	21.9
June	25	62,344	67.1	2.3	64.8	9.2	14.1	15.8	5.0	20.7
July	25	62,757	67.3	.8	66.5	8.1	15.2	8.7	3.8	30.7
August	24	60,304	54.4	1.1	53.3	9.1	13.9	9.4	3.8	17.1

* Annual number of cases per 1,000 members of certain sick benefit associations reporting to the Public Health Service. Only cases lasting 7 days or longer are included.

† Except influenza and grippe.

incidence in the 8-month period, the annual rate was over 50 per 1,000. This is true in spite of the fact that the members of a large proportion of the associations are a selected group.*

In lieu of a more satisfactory basis for classifying the diseases, and in accordance with the recommendations of the American Public Health Association's committee, the groupings appearing in the International List of the Causes of Death have been utilized in our tabulations. On this basis, the outstanding causes of disability are found in the "general" (from 10 to 164 per 1,000), the "respiratory" (from 8 to 50 per 1,000), and the "digestive" (from 14 to 24 per 1,000), these three groups accounting for from 49 to 86 per cent of all disabilities lasting seven days or longer. The wide fluctuation in the general diseases was caused almost entirely by influenza and grippe. Rheumatism does not show so great a seasonal fluctuation as might have been expected; the rate from this cause was high during the period January–June, showing a slight tendency to become less frequent in July and August. The tuberculosis rate varied between 1 and 3 per 1,000 persons per year which seems to indicate a relatively slight disability from tuberculosis lasting seven days or longer. It may be offered in explanation that many cases which actually began in the period under consideration probably had not yet reached a stage involving actual incapacity for work.

It is interesting to note that occupational poisonings are almost entirely absent in this list as a cause of disability. Two possible reasons for this fact may be advanced: (a) That poisonings do not ordinarily incapacitate for as long as seven days, and (b) that they are not accurately diagnosed. The group of respiratory diseases, as may be expected, exhibits a marked seasonal fluctuation. This variation is true of each and all of the diseases in this group, the disabilities caused by bronchitis and pneumonia being the outstanding features. The relatively high rate from the digestive diseases in the first three months of the year is accounted for chiefly by diseases of the pharynx, of which

* Twelve of the 27 associations specify definite age limits for eligibility to membership, the average limits being from 17 to 55 years of age. In some other respects, too, industrial employees are a distinctly selected group. Temporary or casual laborers are seldom admitted to membership, and some may be too poor to afford the cost of insurance. Women have not the privilege of belonging to some of the reporting associations, and in those reporting associations which do have female members their number is relatively small, so that the sickness rates presented could not be affected to any appreciable extent by the greater frequency of illness among women. Furthermore, not all diseases are included in the tabulations, as sick benefits are denied for the venereal diseases, and six of the 27 reporting associations in this group refuse to pay benefits for chronic diseases contracted prior to the date of joining the association. Sixteen of the associations do not pay for disabilities brought on by the use of intoxicating liquors; eleven decline to pay for disabilities resulting from the violation of any civil law; and eight for the results of wilful or gross negligence. Just how rigidly these rules are enforced is not known, but, considering these restrictions, the statistics should be regarded as a *minimum* statement of the disabilities actually occurring and lasting seven days or longer.

TABLE II

ANNUAL NUMBER OF CASES OF SICKNESS CAUSING DISABILITY FOR ONE WEEK OR LONGER PER 1,000 MEMBERS OF SICK-BENEFIT ASSOCIATIONS IN CERTAIN INDUSTRIAL ESTABLISHMENTS REPORTING TO THE PUBLIC HEALTH SERVICE: BY MONTH OF ONSET, JANUARY TO AUGUST, 1920, AND BY DISEASE CAUSING DISABILITY

Disease or condition causing disability (with corresponding title numbers in parentheses from the International List of the Causes of Death)	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
All Diseases and Conditions (a)	275.0	326.7	126.0	103.4	76.7	67.1	67.3	54.4
General Diseases	163.7	218.9	54.2	29.8	16.8	18.1	9.5	10.5
Typhoid fever (1)	1.7	...	.5	.5	.4	..	.4	.6
Influenza and grippe (10)	142.9	201.4	37.1	13.2	4.6	2.3	.8	1.1
Tuberculosis of the lungs (28)	2.5	1.1	3.0	.9	.9	2.3	1.2	1.3
Cancer—all forms (39–46)	...	1.1	.5	.9	.7	...	.6	.8
Rheumatism (47, 48)	6.6	6.8	5.5	7.6	5.0	6.7	3.0	3.6
Occupational poisonings (57, 58)	...	...	...	...	...	.2	...	...
Others (2–9, 11–27, 29–38, 49–56, 59)	10.0	8.5	7.5	6.6	5.2	6.5	3.4	3.2
Diseases of the Nervous System	7.5	8.5	8.0	8.0	5.9	5.0	3.8	3.8
Neuralgia and neuritis (73)	4.2	2.8	2.0	.5	1.7	.8	1.4	1.3
Cerebral hemorrhage, apoplexy and paralysis (64–66)	.8	...	.5	.5	.2	.2	.2	...
Insanity (67, 68)	.8	1.1	1.5	.5	.2	.2	...	.6
Others (60–63, 69–72, 74)	1.7	2.3	3.0	4.3	1.5	2.3	1.6	1.5
Diseases of the eyes (75)	...	.6	...	1.9	1.5	1.1	.4	.4
Diseases of the ears (76)	...	1.7	1.0	.5	.7	.4	.2	...
Diseases of the Circulatory System	2.5	5.1	4.5	3.3	4.8	2.9	4.0	2.1
Diseases of the heart (77–80)	1.7	2.3	1.0	1.4	1.7	1.1	2.2	1.1
Diseases of the veins (83)	.8	2.3	2.5	1.4	1.7	1.5	1.4	.6
Others (81–82, 84–85)	...	.6	1.0	.5	1.3	.4	.4	.4
Diseases of the Respiratory System	49.9	40.8	21.1	19.4	16.8	9.2	8.1	9.1
Bronchitis (89, 90)	21.6	19.3	12.0	8.5	6.3	3.2	3.8	3.4
Pneumonia (91, 92)	15.8	12.5	2.5	4.7	5.0	1.9	1.6	1.9
Others (86–88, 93–98)	12.5	9.1	6.5	6.1	5.5	4.2	2.6	3.8
Diseases of the Digestive System	24.1	22.7	24.1	15.6	15.3	14.1	15.2	13.9
Diseases of the pharynx (100)	15.0	12.5	10.0	7.1	5.5	4.0	3.4	3.4
Diseases of the stomach (102, 103)	4.2	5.1	5.5	3.8	3.1	2.9	4.4	3.6
Diarrhea and enteritis (105)	1.7	1.1	2.0	...	...	1.3	1.0	1.9
Appendicitis (108)	3.3	2.3	2.5	1.9	2.8	2.5	3.4	3.0
Hernia (109)	...	1.1	1.0	2.4	2.4	2.1	.8	1.1
Others (99, 101, 106, 107, 110–118)	...	.6	3.0	.5	1.5	1.3	2.0	1.1
Diseases of the Genito-Urinary System	2.5	3.4	.5	1.4	1.7	1.1	1.4	.6
Acute nephritis and Bright's disease (119, 120)	2.5	.6	...	...	...	.6	...	...
Others (121–133)	...	2.8	.5	1.4	1.7	.4	1.4	.6
The Puerperal State	...	...	...	...	...	...	...	...
Diseases of the Skin and Cellular Tissue	5.8	7.4	2.5	5.2	2.2	2.7	4.9	2.5
Furuncle (143)	3.3	3.4	1.5	3.8	.7	1.3	2.6	.6
Others (142, 144, 145)	2.5	4.0	1.0	1.4	1.5	1.5	2.2	1.9
Diseases of the Bones and Organs of Locomotion	4.2	1.7	3.0	2.4	3.7	1.7	2.4	2.3
Diseases of the bones (146)	.8	.6	...	.5	.7	...	.2	.4
Diseases of the joints (147)	...	...	1.5	.5	1.1	.4	.8	.2
Others (148, 149)	3.3	1.1	1.5	1.4	2.0	1.3	1.4	1.7
Senility	...	...	...	...	...	...	...	...
External Causes (155–186)	3.3	10.8	2.5	13.2	6.1	7.6	12.1	6.3
Ill-Defined Diseases and Conditions (187–189)	11.6	7.4	5.5	5.2	3.3	4.6	5.7	3.2

(a) Except those mentioned in the footnote on p. 591.

tonsillitis is the most important. Disability due to tonsillitis is shown to be astonishingly great. Eliminating pharyngeal affections, the digestive diseases exhibit a fairly constant rate throughout the 8-month period. Seasonal disabilities arising from these causes do not show the anticipated increase in the summer months.

TABLE III

ANNUAL NUMBER OF CASES OF SICKNESS PER 1,000 FOR ALL REPORTING SICK-BENEFIT ASSOCIATIONS, AND FOR EACH REPORTING ASSOCIATION HAVING MORE THAN 500 MEMBERS, BY MONTHS, JANUARY TO AUGUST, 1920[a]

(Where blank spaces appear the statistics were not available)

Sick-benefit associations	Average membership	Number of cases per 1,000 persons per year							
		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.
All reporting associations	41,721	275	327	126	118[b]	80[b]	71[b]	74[b]	59[b]
Group I[c]	34,936	266	283	118	109	71	67	67	55
A	8,528	170	118	60	45	26	38	36	38
B[d]	2,890	548	785	252	175	150	119	120	...
C	6,813	...	272	133	102	77	61	75	53
D	4,125	...	...	...	...	108	101	98	72
E	18,671	...	...	...	...	61	52	46	59
F	3,169	...	...	...	...	...	64	48	40
G	5,286	...	...	...	...	59	65	62	17
H	4,301	...	...	...	204	125	130	170	112
Group II[e]	4,858	362	616	130	120	133	97	101	78
N	879	270	620	148	70	136	70	146	131
O	553	...	461	83	153	43	44	21	21
P	626	527	648	200	151	203	137	39	119
Q	697	328	700	152	157	135	122	101	118
R	1,134	...	...	85	55	94	76	101	51
S	1,193	...	...	...	175	190	97	191	30
T	922	...	...	...	113	111	133	133	95
Others[f]	1,927	132	338	212	208	145	115	154	92

[a] Includes only those sickness and non-industrial accident cases which caused absence from work for one week or longer.

[b] Rate for all reporting associations from April to August differs from the rate for all diseases shown in Table II, because association H, which does not report diagnosis, is included in this table.

[c] Associations which have more than 3,000 members.

[d] Included with the large associations because the membership is nearly 3,000.

[e] Associations which have less than 3,000 members.

[f] Associations which have less than 500 members.

When the frequency rates from all diseases are compared for establishments (see Table III), extraordinarily wide differences are shown in every month. In February, for instance, the frequency rate for association A was 118 per 1,000, while for association B it was 785 per 1,000; and in July Association H had nearly five times as much sickness as Establishment A. It was observed that similar differences appeared in the rates among the smaller associations. These marked differences afford strong reasons for a careful study not only of the causes of illness in the different plants, but of the conditions which give rise to them. Although it is not the purpose to analyze these differences at this time, since the records for the different associations are not sufficiently comparable with respect to the period covered, the value of

statistics of this nature will, it is believed, become more and more manifested as they accumulate.

As an example of the data afforded by records of sickness causing a disability of *one* day or longer, we present a tabulation of the experience of a rubber manufacturing company employing 18,000 persons during the year ending October 31, 1920. Although this company endeavors to obtain the diagnosis of each case of illness by requiring employees resuming work after illness to check in through the medical department, there were a large number of unclassified cases. The illnesses for which no diagnoses were recorded, however, were of short duration, the average being less than 3 working days. It may be assumed, accordingly, that the more serious diseases have been properly classified, and that the unclassified cases probably are mostly colds, headache, constipation, dysmenorrhea, and other conditions that disable for only two or three days. The cases for which no diagnosis was recorded constituted 36 per cent of the male cases and 42 per cent of the female cases, and since the difference is slight, it is believed that comparisons of the recorded diseases according to sex are sufficiently accurate for all practical purposes.

This experience shows a frequency rate of sickness, based on reported cases which terminated within the year, of 1,933 per 1,000 among 16,400 male employees on the factory payroll (office workers not having been included in the record). This is virtually two cases of disabling sickness per man per year. The rate for the 1,625 female factory workers was considerably higher—*i. e.*, 2,565 cases per 1,000.

In view of the estimate of 6.9 working days as the average loss of time per person per year, based on the sickness surveys of the Metropolitan Life Insurance Company in 1916 and 1917, it is interesting to find that the number of work days lost in the rubber manufactory during the year ending October 31, 1920, was 9.3 per male employee, and 13.8 per female employee. The average duration of disability was found to be 4.8 working days per male case, and 5.4 working days per female case. The women, therefore, not only were sick oftener, but failed to recover as rapidly as the men.

Considering first the incidence of the principal groups of diseases among persons of different sex, the statistics for this company show that the frequency of incapacitating illness was greater among the females for all disease groups except diseases of the circulatory system, diseases of the skin, and diseases of the bones, and in each of these three groups the number of female cases was not large enough to be conclusive, but only suggestive of the possibility that a larger number of cases might show the same results. The severity of disease as measured by

TABLE IV

PREVALENCE OF DISABLING DISEASES AMONG EMPLOYEES OF A LARGE RUBBER COMPANY DURING THE YEAR ENDING OCTOBER 31, 1920

Based on reported cases which caused absence from work for one day or longer and which terminated within the year.

Disease or condition causing disability (with corresponding title numbers in parentheses from the International List of the Causes of Death)	Cases per 1,000		Days lost per case		Days lost per person	
	Males	Females	Males	Females	Males	Females
All Diseases and Conditions	1933.0	2565.3	4.81	5.38	9.30	13.80
I General Diseases	275.1	297.2	9.79	12.16	2.69	3.61
Typhoid fever (1)	.5	...	41.25	...	.02	...
Malaria (4)	1.5	4.3	5.04	4.57	.01	.02
Smallpox (5)	3.0	3.7	13.61	12.00	.04	.04
Measles (6)	9.9	14.7	11.81	16.29	.12	.24
Scarlet fever (7)	7.8	16.0	18.47	28.77	.14	.46
Diphtheria and croup (9)	1.0	5.5	7.94	6.33	.01	.04
Influenza and grippe (10)	172.5	180.2	7.21	8.22	1.24	1.48
Dysentery (14)	2.6	2.5	2.21	3.50	...	.01
Erysipelas (18)	1.5	3.1	17.80	17.40	.03	.05
Mumps (19)	18.5	14.8	10.06	11.96	.19	.18
Chicken pox (19)	.6	.6	8.90	5.00	...	...
Infections (20)	9.6	15.4	7.73	5.60	.07	.09
Tuberculosis of the lungs (28)	2.6	2.5	60.86	235.25	.16	.58
Acute miliary tuberculosis (29)	2.0	2.5	47.94	36.00	.10	.09
Tuberculosis of other organs (30–35)	.4	...	38.00	...	.01	...
Syphilis (37)	1.8	3.1	24.13	30.00	.05	.09
Gonococcus Infection (38)	6.1	3.1	9.72	14.60	.06	.04
Cancer—all forms (39–46)	1.0	...	54.50	...	.05	...
Rheumatism (47, 48)	31.1	24.0	10.73	7.46	.33	.18
Diabetes (50)	.2	...	59.25	...	.02	...
Exophthalmic goiter (51)	.2	.6	45.00	16.00	.01	.01
Anaemia (54)	.5	...	70.13	...	.03	...
Alcoholism (56)	.2	...	3.33	...	...	...
Chronic poisonings (57–59)	...	...	...	...	...	...
Other general diseases	...	.6	...	16.00	...	.01
II Diseases of the Nervous System	36.2	40.0	7.67	7.06	.28	.28
Cerebral hemorrhage, apoplexy, and paralysis (64–66)	...	...	...	...	...	...
Mental alienation (67–68)	.4	.6	22.84	6.00	.01	...
Epilepsy (69)	.4	...	6.29	...	...	...
Chorea (72)	...	1.2	...	7.50	...	.01
Neuralgia and neuritis (73)	6.8	12.3	5.71	5.65	.04	.07
Sciatica (73)	1.8	1.2	22.24	30.50	.04	.04
Other diseases of the nervous system	...	...	29.00	...	...	...
Diseases of the eyes (75)	13.7	16.7	5.09	4.52	.07	.07
Diseases of the ears (76)	13.1	8.0	8.94	10.92	.12	.09
III Diseases of the Circulatory System	12.2	9.1	9.05	26.47	.11	.24
Endocarditis and other organic heart diseases (78, 79)	1.3	1.8	17.50	90.33	.02	.17
Hemorrhoids (83)	5.2	1.2	7.92	11.50	.04	.01
Other diseases of the veins (83)	.5	1.2	11.13	17.50	.01	.02
Other diseases of the circulatory system	5.2	4.9	7.82	8.50	.04	.04
IV Diseases of the Respiratory System	279.2	314.4	4.59	6.17	1.28	1.94
Excessive colds (86)	195.8	219.0	3.31	3.91	.65	.86
Other diseases of the nasal fossae (86)	20.7	26.5	3.73	4.35	.08	.12
Diseases of the larynx (87)	5.2	6.8	3.41	6.45	.02	.04
Bronchitis (89, 90)	43.1	37.5	7.95	16.18	.34	.61
Pneumonia (91, 92)	6.2	11.7	14.98	20.79	.09	.24
Pleurisy (93)	6.8	11.7	9.24	6.00	.06	.07
Asthma (96)	1.2	.6	30.65	2.00	.04	...
Other diseases of the respiratory system	.2	.6	12.00	3.00	...	...
V Diseases of the Digestive System	394.3	422.2	4.51	5.68	1.78	2.40
Diseases of the mouth (99)	12.9	23.4	3.63	5.95	.05	.14
Tonsillitis (100)	171.7	238.8	4.99	6.29	.86	1.50
Other diseases of the pharynx (100)	19.5	4.3	3.09	2.86	.06	.01
Ulcer of the stomach (102)	.4	.6	31.43	6.00	.01	...
Other diseases of the stomach (103)	84.1	68.3	3.20	3.80	.27	.26
Diarrhoea and enteritis (105)	26.7	25.2	3.03	3.07	.08	.08
Appendicitis and typhlitis (108)	11.2	13.6	14.79	16.18	.16	.22
Hernia (109)	4.1	1.8	21.93	12.33	.09	.02
Constipation (110)	37.3	12.3	2.56	2.10	.10	.03
Other diseases of intestines (110)	24.5	30.2	3.24	3.18	.08	.10
Biliary calculi (114)	.2	.6	7.33	3.00	...	...
Other diseases of the digestive system	1.7	3.1	10.57	13.00	.02	.04

TABLE IV—*Continued*

Disease or condition causing disability (with corresponding title numbers in parentheses from the International List of the Causes of Death)	Case per 1,000		Days lost per case		Days lost per person	
	Males	Females	Males	Females	Males	Females
VI Diseases of Genito-Urinary System	5.4	190.1	14.35	5.71	.08	1.09
Nephritis and Bright's disease (119, 120)	.8	5.5	28.21	56.56	.02	.31
Diseases of the bladder (124)	1.2	7.4	5.68	4.08	.01	.03
Diseases of the testicles (127)	2.7	...	7.38	...	.02	...
Uterine hemorrhage (128)	...	12.3	...	16.70	...	.21
Dysmenorrhea (130)	...	151.4	...	2.58	...	.39
Other diseases of female genitals	...	13.5	...	10.82	...	.15
Other diseases of genito-urinary system	.7	...	40.18	..	.03	...
VII The Puerperal State	...	16.6	...	24.93	...	.42
VIII Diseases of the Skin	51.5	25.8	5.62	6.38	.29	.16
Gangrene (142)	.1	.6	4.00	4.00	...	...
Furuncle (143)	27.4	3.7	4.79	3.50	.13	.01
Acute abscess (144)	5.2	9.9	8.93	6.94	.05	.07
Rash-benzine (145)	5.1	2.5	7.48	4.00	.04	.01
Other diseases of the skin	13.7	9.1	5.34	7.73	.07	.07
IX Diseases of the Bones and Organs of Locomotion	41.1	22.7	5.10	6.24	.21	.14
Diseases of the bones (146)	1.2	.6	10.79	55.00	.01	.03
Diseases of the joints (147)	.8	.6	7.15	7.00	.01	.01
Lumbago (149)	13.2	3.7	5.43	8.00	.07	.03
Myalgia (149)	20.5	14.8	4.12	4.08	.09	.06
Flat feet (149)	4.6	1.8	7.08	6.00	.03	.01
Other diseases of the bones, and organs of locomotion	.8	1.2	3.14	2.50	...	...
XII Senility	..	...	147.00	...	.01	...
XIII External Causes	45.6	48.6	7.52	6.81	.34	.33
Poisoning by food or drugs (164)	.4	3.7	5.20	6.83	...	.02
Fractures (185)	.9	2.5	23.27	23.75	.02	.06
Other injuries (186)	44.3	42.4	7.21	5.83	.32	.25
XIV Ill-Defined	792.4	1178.6	2.82	2.71	2.23	3.19
Headache (2–189)	87.4	94.8	2.63	3.20	.23	.30
Others	705.0	1083.8	2.84	2.66	2.00	2.89

the days lost per case was greater among the females for each principle disease group except diseases of the nervous system, non-industrial accidents, and diseases of the genito-urinary system. The comparatively short duration of disease of the genito-urinary system among the females is accounted for by the large number of cases and brief duration of dysmenorrhea.

But what specific diseases and conditions were most prevalent among the rubber workers under consideration? The most frequent cause of disability among the males was "excessive colds" for which the case rate was 196 per 1,000. Though severe colds were more frequent among the females than among the males, colds were not the first cause of disability among the women employees. Tonsillitis with a rate of 239 cases per 1,000 was the most frequent cause of female inability to work. There were 388 cases of tonsillitis among 1,625 women, causing an absence of 6.3 days per case, and a day and a half of lost time per woman per year. Severe colds among the men inca-

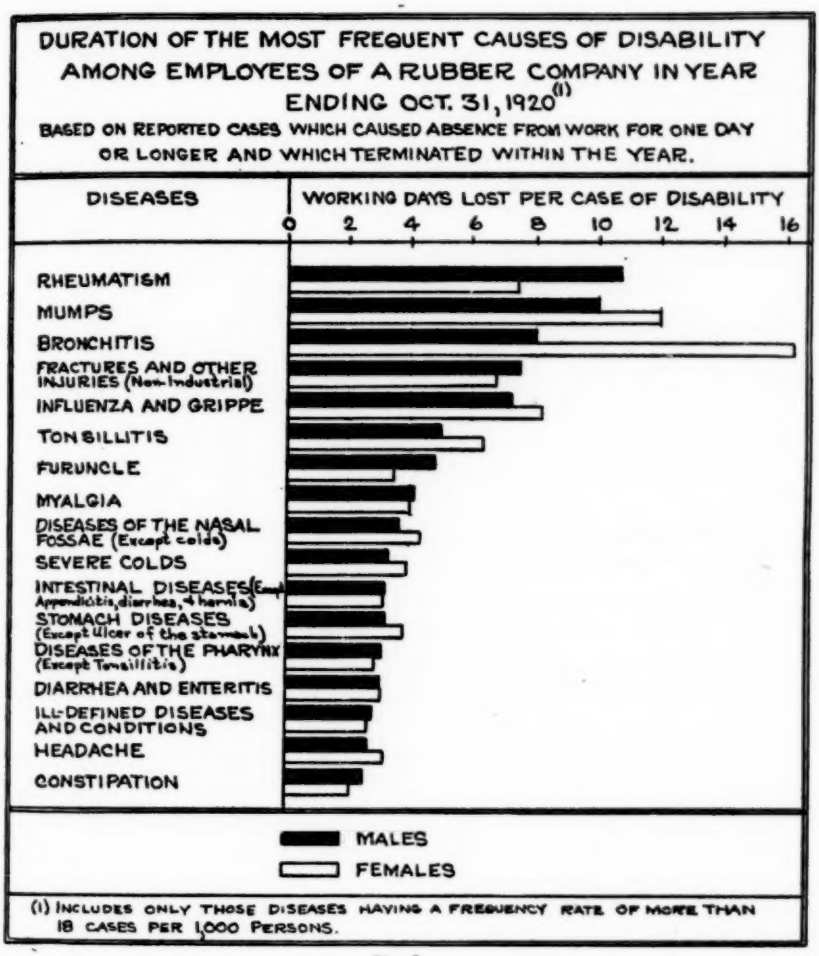

DURATION OF THE MOST FREQUENT CAUSES OF DISABILITY AMONG EMPLOYEES OF A RUBBER COMPANY IN YEAR ENDING OCT. 31, 1920(1)
BASED ON REPORTED CASES WHICH CAUSED ABSENCE FROM WORK FOR ONE DAY OR LONGER AND WHICH TERMINATED WITHIN THE YEAR.
DISEASES
WORKING DAYS LOST PER CASE OF DISABILITY
0 2 4 6 8 10 12 14 16
RHEUMATISM
MUMPS
BRONCHITIS
FRACTURES AND OTHER INJURIES (Non-Industrial)
INFLUENZA AND GRIPPE
TONSILLITIS
FURUNCLE
MYALGIA
DISEASES OF THE NASAL FOSSAE (Except colds)
SEVERE COLDS
INTESTINAL DISEASES (Except Appendicitis, diarrhea, & hernia)
STOMACH DISEASES (Except Ulcer of the stomach)
DISEASES OF THE PHARYNX (Except Tonsillitis)
DIARRHEA AND ENTERITIS
ILL-DEFINED DISEASES AND CONDITIONS
HEADACHE
CONSTIPATION
MALES
FEMALES
(1) INCLUDES ONLY THOSE DISEASES HAVING A FREQUENCY RATE OF MORE THAN 18 CASES PER 1,000 PERSONS.

Fig. 2.

pacitated on the average for 3.3 working days, causing a loss of 0.7 of a day per man per year. Among the women hard colds caused an average disability of 3.9 working days per case and 0.9 of a working day per person per year. Influenza and grippe ranked second in point of frequency among the males, and third among the females. Two thousand eight hundred and twenty-seven male cases averaged 7.2 working days lost, and 293 female cases, 8.2 working days lost. Dysmenorrhea was the fourth greatest cause of disability among the women, causing an absence of 2.6 working days per case.

Other interesting sex comparisons might be cited. Headache, for example, was only slightly more frequent among females than among

males. The women were not attacked by bronchitis as frequently as were the men, and their rate for constipation was only one-third of the male rate. The female rate for rheumatism was less than the male rate, and the frequency of boils (furuncle) was only one-seventh of the male rate for this cause of incapacity for work. The women had neuralgia and neuritis more often than the men, and also diseases of the eyes; but men had more diseases of the circulatory system, possibly partly for the reason that a larger proportion were in the older ages. Other points will doubtless suggest themselves to those who desire to examine the tables in greater detail.

Attention is called to Figure 2 which shows the duration of the most frequent causes of disability among both male and female employees of the company.

These two tabulations are presented merely as samples of the material which is afforded in the records of industrial establishments. It is obvious that they are not so complete or so accurate as may be desired, but it is believed that they constitute a definite advance over the fragmentary data available from health departments. It is believed also that when the data are collected in a larger mass, for a longer period, and in greater detail for persons of different occupational status, race, sex, and age, they will afford the first considerable body of dependable material for the use of the statistician in the study of disease incidence as well as for the student of industrial hygiene in its broader aspects. Certainly the employer who desires to know definitely how he can improve most effectively the health of his workers will be aided not only by a more careful scrutiny of his own records when they are intelligently tabulated and analyzed, but by the accumulated experience of other plants.

MORTALITY RATES OF COLLEGE WOMEN

By Myra M. Hulst, *American Red Cross*

This investigation was begun at the suggestion of Dr. Louis I. Dublin, Statistician for the Metropolitan Life Insurance Company and Lecturer in Vital Statistics at Yale University, and has been carried out with helpful suggestions from him. A grant made by the American Association for the Advancement of Science has defrayed the expenses involved.

The gathering of the data for this study was begun in 1918, and at that time the intention was to study the mortality rates among the graduates of the eight largest woman's colleges* used in the report on college women's occupations made by Miss Mary Van Kleeck of the Russell Sage Foundation. It was found impossible to do this because of the enormous amount of labor involved. The graduates from Vassar, Wellesley, and Smith, which included a large proportion of the alumnae of the eight colleges, were finally chosen for study. Of the 22,692 women graduating since the founding of the eight colleges, through the class of 1914, there were 15,561 graduates from Vassar, Wellesley, and Smith, or 68.6 per cent of all the alumnae from these eight colleges.

Investigations of the mortality rates for special groups present many obstacles, chief of which is the great difficulty of following a sufficient number of persons throughout their lives. College women present fewer difficulties than would be encountered in most other groups. Records taken in their college days of the dates of birth are available, as are also the facts of death as they occur among the graduates and are recorded by alumnae associations and the college registrars.

There is, no doubt, much in common in the habits, modes of life, and general circumstances of these women, which makes them a homogeneous group for study. They start out in life from college at approximately the same age. The median age at graduation for this whole group was twenty-two years. The environmental conditions, both before and after graduation, would be, on the whole, admittedly more favorable than the average for the community at large. The large number of old American family names among them would lead one to conclude that most of them are women of native stock.

* These included Barnard, Bryn Mawr, Mt. Holyoke, Radcliffe, Smith, Vassar, Wellesley, and Wells.

In the gathering of the necessary data for study, three facts were noted concerning each graduate: the year of graduation, the date of birth, and whether deceased or not; and if dead, the date of death. To this end the Collegiate Alumnae Association generously lent the records which they had collected in the earlier census of the occupations of college women. These records, however, were not complete for a considerable proportion of graduates, and it was necessary to supplement their files. This was done through the coöperation of the registrars of the colleges, and from alumnae catalogues and bulletins. Every effort was made to complete the records for the graduates, both living and dead, of the three colleges. The material was altogether in very excellent condition at Smith and Vassar Colleges; but in a few cases where certain items, such as the date of death, were not available, they were obtained by writing to friends or relatives of the deceased. A fire had destroyed part of the Wellesley records, so that they were somewhat less complete than the records of the other colleges. By correspondence with alumnae some missing dates were found, making less than 3.5 per cent of the total dates of birth as unknown in the case of Wellesley, which was too small a percentage to affect the final results. In a few instances, where no date of birth was known, the person was considered 22 years of age at graduation, this being the median age at graduation for all colleges. Tabulations were made on the exposure year basis, beginning with the first of July and running through to June 30. This was necessitated by the fact that the date of graduation is in the middle of the calendar year at all schools.

The facts were then tabulated separately for each class of graduates. Every individual was followed up to July, 1915, and was dropped out of the count only in the event of her death. It was impracticable to carry the study further than 1915 because of the danger that some of the deaths subsequent to this date would not be known to the college authorities. The number of years of life exposed were in this way obtained for each age. They were later grouped by five and ten year periods, first for each class, and then for all classes of each college. These were found to accumulate to 66,885 years between the ages of 20 and 69 years for Vassar, 72,415 years between the ages of 20 and 59 for Smith, and 65,253 years between the ages of 20 and 64 for Wellesley. This gave a total of 204,553 years of life exposed for the whole study. The number of deaths was likewise obtained for each one of the age periods. Table 1 shows for each college, Vassar, Wellesley, and Smith, the exposure, the number of deaths, and the death rates per 1,000 for each of the age periods:

TABLE 1A

DEATH-RATES PER 1,000 EXPOSED. VASSAR COLLEGE ALUMNAE 1867–1914

Age period	Years of life exposed	Deaths	Death-rate per 1,000 exposed
20 to 69—total	66,885.08	278	4.16
20 to 24	12,357.58	17	1.38
25 to 34	30,436.10	99	3.25
35 to 44	14,282.64	65	4.55
45 to 54	6,672.50	57	8.54
55 to 64	2,879.25	34	11.81
65 to 69	257.01	6	23.34

TABLE 1B

DEATH-RATES PER 1,000 EXPOSED. SMITH COLLEGE ALUMNAE 1879–1914

Age period	Years of life exposed	Deaths	Death-rate per 1,000 exposed
20 to 59—total	72,414.68	185	2.55
20 to 24	14,439.92	18	1.25
25 to 34	38,723.02	100	2.58
35 to 44	15,351.00	50	3.26
45 to 54	3,673.65	13	3.54
55 to 59	227.09	4	17.61

TABLE 1C

DEATH-RATES PER 1,000 EXPOSED. WELLESLEY COLLEGE ALUMNAE 1879–1914

Age period	Years of life exposed	Deaths	Death-rate per 1,000 exposed
20 to 64—total	65,252.75	205	3.14
20 to 24	11,836.09	18	1.52
25 to 34	32,859.25	84	2.56
35 to 44	15,605.99	73	4.68
45 to 54	4,622.33	25	5.41
55 to 64	329.09	5	15.19

The specific death-rates for the graduates of Vassar College present a much more consistent picture of mortality than those for either Wellesley or Smith. The rates increase regularly with advancing age and, for the most part, are in close agreement with specific death-rates available for similar groups previously studied. As shown in Table 2, the findings for the graduates of Vassar College are in close agreement with those for New York City school teachers and for women insured in the Ordinary Department of the Metropolitan Life Insurance Company. The rates are very much lower than for women in the Registration Area of the United States; but these differences are to be expected in view of the more favorable social and economic condition of these Vassar graduates, their greater knowledge and very probable practice of personal hygiene, their less arduous and protected occupa-

tions, and their relative freedom from the hazards incident to childbearing.

The death-rates for Wellesley Alumnae also show an increase at each succeeding age period. The rise in the death-rate with advancing age does not take place so rapidly or so consistently as in the case of Vassar's mortality. At the age period 25 to 34 years, the rate for Wellesley is slightly lower than that for Vassar, and at the age 45 to 54 years, Vassar presents a death-rate considerably higher than that of Wellesley. At the highest age period represented by Wellesley, 55 to 64 years, the rate shows an excess over that of Vassar; but the years of life exposed at this age period are too few to be of particular significance.

The facts for the alumnae of Smith College are very surprising indeed. The death-rates are lower than those for Vassar or Wellesley, but the difference is most marked in the age period 45 to 54, where the rate, 3.54, is less than one-half that for Vassar. In view of these findings, additional effort was made to certify to the accuracy of the data. Every possible channel was employed to discover unrecorded deaths. Letters were sent to each of the class secretaries from 1879 to 1895, which included the graduates who would be in the age period in which the extraordinary low death-rate occurred. Replies were received from each one of these secretaries and the record of only one additional death was obtained. There was no deceased member in the class of 1883 out of a total of 49 graduates. We quote here the reply received from the secretary of this unique class: "None of the 49 graduates of the class of 1883 has died—a record unequalled so far as I know in any class of men or women." This fact was further corroborated by emphatic statements from other members of the class. Another secretary certified to the record of only one deceased member in her class. Others confirmed our findings to the letter. In spite of the exceptional character of these figures for Smith College, we present them herewith with the assurance that they represent the truth as far as this college is concerned. It must be realized that the number of years of life exposed in the age period 45 to 54 is comparatively small. The death-rate is, therefore, subject to the error arising from small numbers. The number of years of life exposed for Smith College at this age period is only half that of Vassar. The Vassar experience started with the first class graduating in 1867, and for Smith and Wellesley Colleges, the first alumnae graduated in 1879, which gives a much larger proportion of graduates for Vassar who have reached the higher age periods than for either of the other two colleges studied. But in view of the consistently lower death-rate in Smith for every age

period, there is suggested the possibility that the differences in the figures represent real differences in the vitality of the graduates of the three colleges studied. Table 2 presents a comparison of the specific death-rates for the three colleges and for the other groups of women for which data are available:

TABLE 2

DEATH-RATES PER 1,000 WOMEN, VASSAR, WELLESLEY, AND SMITH ALUMNAE. METROPOLITAN LIFE INSURANCE COMPANY—ORDINARY DEPARTMENT EXPERIENCE—1914–1916. NEW YORK CITY TEACHERS, 1907–1914, AND REGISTRATION AREA, 1910–1915

Age period	Vassar Alumnae	Wellesley Alumnae	Smith Alumnae	Ordinary Ins. Experience, M. L. I. Co.	N. Y. City Teachers	U. S. Reg. W. A. Area
20 to 24.....	1.38	1.52	1.25	....	1.48	4.96
25 to 34.....	3.25	2.56	2.58	3.02	2.98	6.10
35 to 44.....	4.55	4.68	3.26	4.83	4.32	8.03
45 to 54.....	8.54	5.41	3.54	9.16	9.84	12.58
55 to 64.....	11.81	15.19	...	20.04	16.67	24.48

In this table special interest attaches to the figures for New York City Teachers, taken from an investigation by Mr. George Buck on Teachers' Pensions. The death-rates for all periods are found to be very much like those for college graduates. They are more in accordance with the rates for Vassar Alumnae than for either of the other two colleges; the only appreciable difference between these two groups being at the age period of 55 to 64 years. In the case of Wellesley the difference begins at a lower age period, 45 to 54 years; at the next age period, 55 to 64, the rate for Wellesley is but slightly less than that for New York teachers.

The study made of school teachers' mortality is the most comparable to that of college women of any special mortality experience which has been computed. The age distribution of school teachers and college women is much the same, the majority of them being in the period of 20 to 34 years of age. Teaching is the occupation of a large proportion of college women. In the study of college women's occupations, it was found that 58 per cent of all graduates prior to war conditions had been engaged in teaching. It is to be expected that we should find college women and school teachers agreeing in such low rates of mortality. This low rate of mortality is thus commented upon in the Pension Study of New York City Employees, Report on the Pension Fund of the City of New York, Commission on Pension, 1916. Part II, p. 102: "The death-rate as a whole is lower among women teachers than any other class except men teachers and members of the College of the City

of New York Retirement Fund. The death-rates for teachers were found to be the lowest existing in New York City service."

Table 3 presents for each age period from 20 to 64 the death-rates of college women as computed from the combined mortality of Vassar, Wellesley, and Smith graduates. The mortality experience of these women shows a very low rate for each age period in comparison with the general female population of the United States.

TABLE 3

DEATH-RATES PER 1,000 EXPOSED OF COLLEGE WOMEN. RATES FOR VASSAR, WELLESLEY, AND SMITH COLLEGES COMBINED

Age period	Years of life exposed	Deaths	Death-rate per 1,000 exposed
20 to 64—total	204,295.50	662	3.24
20 to 24	38,633.59	53	1.37
25 to 34	102,018.37	283	2.77
35 to 44	45,239.63	188	4.15
45 to 54	14,968.48	95	6.35
55 to 64	3,435.43	43	12.52

The crude death-rate for each college studied is also very low. In the case of Vassar, which had the greatest number of alumnae in the higher age periods, the ages 20 to 69 are included, and give a crude rate for these ages of 4.16 per 1,000 exposed. Smith, which has too few alumnae above the ages 20 to 59 to include any higher ages, gives a crude rate of 2.55; and Wellesley for the period 20 to 64 years has a rate of 3.14 per 1,000.

As we do not know what the causes of death for these college women are, we can only conjecture what some of the factors may be which result in such a favorable mortality. In the first place, they evidently were a highly selected group of women, with excellent health, to have been able to pass through four years of college. During these years they enjoyed an exceptionally good environment, and opportunities were afforded them for physical exercise, both through outdoor sports and gymnastics which are usually required of students during part of their college course. Physical and medical examinations given to all students result in the discovery of defects which can be remedied. Even in the earliest years of Vassar we find that very complete physical records of the students were taken. It is to be expected, too, that they would have learned under these unusually healthful conditions of life the proper adjustment to work, and to rest and amusement, which are considered important elements in the prolongation of life.

It is a generally accepted fact that classes well enough off economically to be able to provide themselves with adequate medical care and

a good, healthful, sanitary environment can prolong their lives beyond those less fortunate. College women belong to a class that is fairly well-off economically. Of the women reporting their earnings in the *Census of College Women* referred to above, the median income in 1914 was $1,013. This was high in comparison with the earnings of women of the industrial classes for that year. Professor Irving Fisher, of Yale University, has emphasized the effect of economic conditions in these words: "That a well-to-do class, properly fed and clothed, and with opportunity for leisure, will be less susceptible to disease than a poverty-stricken class, ill-fed and over-worked, has been repeatedly shown by statistics."

College women are not so much exposed to the causes of death incidental to child-bearing as are other women. The census of Miss Van Kleeck shows that in 1915 there was married an average of about 50 per cent of the classes graduating prior to 1900. For Vassar, the total proportion of those who had married in all classes through the year 1915 was 45.1 per cent; 38.3 per cent for Wellesley, and 44.5 per cent for Smith. These figures show that less than one-half of college graduates are exposed to the hazards of childbirth, which is a much smaller proportion than among other women. The families borne by college graduates are also exceptionally small. It was found that they averaged but 2.1 children per family for all married graduates; and among married graduates in classes prior to 1890, whose families would be completed, the average number of children is also low, being 2.8. Between the ages of 15 and 45 years, statistics show that more deaths among women are caused by hazards of child-bearing than by any other cause except tuberculosis. Many of these deaths are due to inadequate care or lack of proper medical attention—a condition which would rarely be found among college women.

Our results, which show a remarkably low mortality rate among college women, are, therefore, not surprising. The results obtained indicate how much saving in mortality can be accomplished through extending to other women of the country the advantages which these college women enjoy. The conditions among them may be set up as a standard for the rest—a goal to be attained. The effect on the death-rate in the country at large would be tremendous if only half the difference were wiped out.

RAPID METHODS OF APPROXIMATING TO TERMS IN A BINOMIAL EXPANSION

By George F. McEwen, *Scripps Institution for Biological Research, University of California*

CONTENTS

1. Introduction. 2. The Symmetrical Binomial. 3. The Asymmetrical or Skew Binomial. 4. References Cited.

1. INTRODUCTION

The labor of computing terms or sums of terms in a binomial expansion can be greatly reduced by the use of certain continuous functions approximating to the values desired. Although these functions are treated in many texts and papers, the simple transformations and substitutions required to obtain formulae directly applicable to computations pertaining to binomial series are in general left for the student to make.

This paper brings together the most suitable of these functions and illustrates their use in order to meet the needs of investigators wishing to obtain numerical results as readily as possible.

2. THE SYMMETRICAL BINOMIAL

The xth term counted from the middle one in the expansion of the symmetrical binomial*

$$\left(\frac{1}{2}+\frac{1}{2}\right)^n=\left(\frac{1}{2}\right)^n+n\left(\frac{1}{2}\right)^n+\frac{n(n-1)}{1\cdot 2}\left(\frac{1}{2}\right)^n+\frac{n(n-1)(n-2)}{1\cdot 2\cdot 3}\left(\frac{1}{2}\right)^n+\ \ldots \tag{1}$$

where the number of the term is

$$r=1,\ 2,\ 3,\ 4\ \ldots \tag{2}$$

is approximately given by the familiar exponential expression (Yule, 1911, p. 300; Merriman and Woodward, 1900, pp. 482–483)

* When n is even, there are an odd number $(n+1)$ of terms, and corresponding to the middle term which is also the maximum, x has the value zero.

When n is odd, there are an even number $(n+1)$ of terms, the two central ones are equal, and the corresponding values of x are, respectively $+\frac{1}{2}$ and $-\frac{1}{2}$.

In both cases

$$r=\frac{n}{2}+1+x$$

or

$$x=r-\frac{n+1}{2}-\frac{1}{2}.$$

$$y = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}} = \frac{.399}{\sigma} e^{-\frac{x^2}{2\sigma^2}} \tag{3}$$

where

$$\sigma = \text{the standard deviation} = \tfrac{1}{2}\sqrt{n} \tag{4}$$

and

$e = 2.7183$, the Naperian base of logarithms.

With the aid of a tabulation of this exponential function (Davenport, 1899, p. 21 and 54; Fowle, 1914, pp. 48–54) its value can be quickly found when n and x are given. The difference between this function and the corresponding term of the binomial series decreases as n increases, but the approximation is close even when n is as small as 8, as shown by Table I.

TABLE I

VALUES OF TERMS IN THE BINOMIAL EXPANSION COMPARED WITH THE CORRESPONDING EXPONENTIAL FUNCTION

r	x	y	Terms of the expansion $(\frac{1}{2}+\frac{1}{2})^8$
1	−4	.0052	.0039
2	−3	.0313	.0313
3	−2	.1038	.1092
4	−1	.2198	.2184
5	−0	.2822	.2730

To compute the value of y, substitute 8 for n in the general expression

$$y = \frac{.798}{\sqrt{n}} e^{-\frac{2x^2}{n}} \tag{5}$$

obtained from equations (3) and (4), thus obtaining

$$y = .2822\, e^{-\frac{x^2}{4}}. \tag{6}$$

To find y for a given value of x (x is negative for terms to the left of the middle one), say, $x = -2$, substitute -2 for x in equation (6) and find the value of $e^{-\frac{2^2}{4}} = e^{-1} = \frac{1}{e}$ from table 18 (Fowle, 1914, p. 49). Thus

$$y = (.2822)(.3679) = .1038. \tag{7}$$

To use Davenport's (1899) table (p. 54), find from equation (4)

$$\sigma = \tfrac{1}{2}\sqrt{8} = \sqrt{2}. \tag{8}$$

Thus for $x = -2$

$$\frac{x}{\sigma} = -\frac{2}{\sqrt{2}} = -\sqrt{2} = -1.414 \tag{9}$$

$$\frac{y}{y_0} = e^{-\frac{x^2}{2\sigma^2}} = .3753 - .14(.3753 - .3246) = .368 \tag{10}$$

and as before

$$y = (.2822)(.368) = .1038. \tag{11}$$

If n equals the odd number, 9, substitution in equation (5) gives

$$y = .266e^{-\frac{2}{9}x^2}, \tag{13}$$

from which the entries in column 3 of Table II were computed.

TABLE II

VALUES OF TERMS IN THE BINOMIAL EXPANSION COMPARED WITH THE CORRESPONDING EXPONENTIAL FUNCTION

r	x	y	Terms of the expansion $(\frac{1}{2}+\frac{1}{2})^9$
1	−4.5	0.0030	0.0020
2	−3.5	0.0175	0.0176
3	−2.5	0.0663	0.0704
4	−1.5	0.1622	0.1640
5	−.5	0.2516	0.2460
6	.5	0.2516	0.2460

A continuous function approximating to the terms of a series is especially useful in computing the sum of a given number of terms, since another continuous function approximating to this sum results from integration. Thus the sum of any number (x) of terms counted from the middle or zero'th term of the binomial expansion is given approximately by the integral

$$\int_0^x y\,dx = \frac{1}{\sqrt{2\pi}\sigma}\int_0^x e^{-\frac{x^2}{2\sigma^2}}dx = \sqrt{\frac{2}{\pi n}}\int_0^x e^{-\frac{2x^2}{n}}dx \tag{14}$$

where y is given by equation (3), or (5).

Substitution of a new variable $t=x\sqrt{\frac{2}{n}}$ in equation (14) gives the well-known "probability integral"*

$$\int_o^x ydx=\frac{1}{\sqrt{\pi}}\int_o^t e^{-t^2}dt \tag{15}$$

whose values are tabulated in various books on statistics and least squares (for example, Yule, 1911, p. 306; Davenport, 1899, p. 55; Broggi, 1911, pp. 354–356; Fowle, 1914, p. 56; Merriman, 1903, p. 220).

When n is even, if x has the value $\pm\frac{1}{2}$, the integral (14) or (15) gives $\frac{1}{2}$ of the middle term, for $x=\pm(1+\frac{1}{2})$ the integral gives the value of $\frac{1}{2}$ the middle term, plus the next term, and so on.

When n is odd, if x has the value ±1, the integral (14) or (15) gives one of the two central terms, for $x=\pm2$ the integral gives one of the two central terms plus that of an adjacent term, and so on.

To find the sum of the first r terms [counting the 1st term as one, see equations (1) and (2)], find the sum from the middle term to, but not including the r th term, and subtract the result from $\frac{1}{2}$, which is the sum of the first $\frac{n+1}{2}$ terms. That is, for odd or even values of n

$$x=\left(r-\frac{n+1}{2}\right) \tag{16}$$

and the sum of first r terms is

$$\tfrac{1}{2}\left\{1-\frac{2}{\sqrt{\pi}}\int_o^t e^{-t^2}dt\right\} \tag{17}$$

where

$$t=x\sqrt{\frac{2}{n}}=-\frac{n-2r+1}{\sqrt{2n}}. \tag{18}$$

Table III gives the sum of portions of several binomial expansions,

* To determine the probability of obtaining any proportion of an equal number of each of two different things, put

$$\theta=\frac{x}{n} \text{ or } x=n\theta$$

where θ is the difference between the true proportion, $\frac{1}{2}$ and the observed proportion, then

$$t=\theta n\sqrt{\frac{2}{n}}=\theta\sqrt{2n}.$$

This agrees with the result derived by Hatai (1910) from the theorem of Bayes for determining the probability that the true proportion differs by θ from the observed value.

taken from a biological paper (Sumner, 1910, p. 330), and the approximation to these sums given by the "probability integral."

TABLE III

SUMS OF TERMS IN CERTAIN BINOMIAL EXPANSIONS AND CORRESPONDING VALUES OBTAINED FROM THE PROBABILITY INTEGRAL

n	r	$n-2r+1$	$\sqrt{2n}$	t equals $\frac{n-2r+1}{\sqrt{2n}}$	$\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$	$1-\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$	$\frac{1}{2}\left[1-\frac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt\right]$	Sum of terms of binomial
10	2	7	4.472	1.566	.9732	.0268	.0134	.0193
11	1	10	4.691	2.133	.9974	.0026	.0013	.0005*
11	3	6	4.691	1.280	.9297	.0703	.0351	.0327
11	4	4	4.691	.853	.7725	.2275	.1137	.1111
18	6	7	6.000	1.167	.9011	.0989	.0494	.0588
19	4	12	6.160	1.948	.9941	.0059	.0029	.0022
19	6	8	6.160	1.298	.9336	.0664	.0332	.0318
32	7	19	8.000	2.375	.9992	.0008	.0004	.00041
56	14	29	10.580	2.745	.9999	.0001	.00005	.00005

* The approximation is closer as r increases, and for computing one or two terms the binomial series itself should be used, instead of the integral.

To illustrate the process, determine the sum of the first 7 terms in the expansion

$$\left(\frac{1}{2}+\frac{1}{2}\right)^{32}=\left(\frac{1}{2}\right)^{32}+32\left(\frac{1}{2}\right)^{32}+\frac{32\cdot 31}{1\cdot 2}\left(\frac{1}{2}\right)^{32}+\ \cdots$$

$$r=1,\ 2,\ 3,\ \cdots \tag{19}$$

Here,

$$n=32,\ r=7,\ n-2r+1=19 \tag{20}$$

and $t=\dfrac{19}{\sqrt{2\cdot 32}}=2.375$ (Table III, line 8). The corresponding value of the integral $\dfrac{2}{\sqrt{\pi}}\int_0^t e^{-t^2}dt$ (Merriman, 1903, p. 220), is .9992, and $\frac{1}{2}(1-.9992)=.0004$ the approximate value, which agrees well with .00041, the sum of the first 7 terms of the series (equation 19).

To use Table IV (Davenport, 1899, p. 55) the above expression for t must be replaced by

$$\frac{x}{\sigma}=\frac{\frac{n+1}{2}-r}{\frac{1}{2}\sqrt{n}}=\frac{n-2r+1}{\sqrt{n}},$$

and the tabular entry must be subtracted from $\frac{1}{2}$. If $n=32$, and $r=7$,

$$\frac{x}{\sigma}=\frac{32-14+1}{\sqrt{32}}=\frac{19}{\sqrt{32}}=3.360$$

and the corresponding tabular entry is .4996. The approximation to the sum is therefore $.5000-.4996=.0004$.

3. THE ASYMMETRICAL OR SKEW BINOMIAL

A function bearing the same relation to the skew binomial

$$\left.\begin{array}{l}(p+q)^n=p^n+np^{n-1}q+\dfrac{n(n-1)}{1\cdot 2}p^{n-2}q^2+\ \ldots \\ r=1,\qquad 2,\qquad\qquad 3,\qquad\quad \ldots \\ p\neq q\end{array}\right\} \tag{21}$$

as the normal probability function bears to the symmetrical binomial was first found by E. L. Deforest (1882–3). In a review of Deforest's researches, Shinkishi Hatai (1910) presents a derivation of Deforest's (1882–3) formula

$$y=\frac{1}{k\sqrt{2\pi b}}\left(1+\frac{x}{ab}\right)^{a^2b-1}e^{-ax}. \tag{22}$$

Where y is the approximate value of the xth term in the binomial series, the *mean* term $r=(nq+1)$ being the origin,

$$\left.\begin{array}{l}k=1+\dfrac{1}{12a^2b}+\dfrac{1}{288(a^2b)^2}+\ \ldots \\ a=\dfrac{2\mu_2}{\mu_3},\ b=\mu_2\end{array}\right\} \tag{23}$$

μ_2 and μ_3 are respectively the second and third moments about the mean. These moments* of the binomial series are (Pearson, 1906–7,

* By definition, the second moment $\mu_2=\dfrac{\Sigma f\cdot x^2}{N}$, where f is the frequency of a deviation x, and $N=\Sigma f=$ the sum of all the frequencies. If the interval between successive terms equals L, instead of unity, as assumed in the preceeding pages,

$$\mu_2=\frac{\Sigma f\cdot x^2\cdot L^2}{N},$$

since the deviation is xL. For a binomial series, the corresponding standard deviation becomes

$$\sigma=\sqrt{\mu_2}=\left\{\sqrt{\frac{\Sigma f\cdot x^2}{N}}\right\}L=\sqrt{npq}L.$$

If the total range, nL is denoted by R, the standard deviation becomes

$$\sigma=\left(\sqrt{npq}\right)\frac{R}{N}=\left(\sqrt{\frac{pq}{n}}\right)R.$$

p. 172; Greenwood, 1913, p. 71)

$$\left.\begin{aligned}\mu_2 &= npq \\ \mu_3 &= npq(p-q)\end{aligned}\right\} \qquad (24)$$

To illustrate the use of Deforest's rule, compute the rth term of the expansion $(.9+.1)^{20}$. By definition

$$p=.9,\ q=.1,\ n=20,\ 20\times.1+1=3$$

mean term or origin,

$$\mu_2=(20)(.9)(.1)=1.8$$

$$\mu_3=(20)(.9)(.1)(.9-.1)=1.44$$

$$a=\frac{2\times1.8}{1.44}=2.5,\ b=1.8,\ a^2b=11.25$$

$$k=1+\frac{1}{(12)(2.5)^2(1.8)}+\frac{1}{(288)[(2.5)^2(1.8)]^2}=1.0076.$$

Therefore

$$y=.295\left(1+\frac{2}{9}x\right)^{10.25}e^{-2.5x} \qquad (25)$$

where $x=(r-$ mean term$)=r-3$.

To obtain the third term put $x=0$, then $y=\quad .295.$

To obtain the 6th term, put $x=3$, then

$$\log .295 = \quad 9.46982-10$$

$$10.25\log\left(\frac{5}{3}\right)=(10.25)(.221858)= \quad 2.27404$$

$$-7.5\log e=(-7.5)(.43429)=-3.25717$$

$$\log y = \quad 8.48669-10$$

$$y = \quad .03067.$$

As shown by Hatai (1910), Deforest's formula is equivalent to Pearson's Type III curve whose equation (referred to the mode as origin) is (Pearson 1914, p. xvl)

$$y=y_0e^{-\nu x}\left(1+\frac{\nu x}{m}\right)^m. \qquad (26)$$

In computing terms of a binomial expansion by means of equation (26), the constants have the values (Pearson, 1906–7)

$$m=\frac{4}{npq-\frac{4}{n}}-1,\ \nu=\frac{2}{p-q}$$

$$y_0 = \frac{\nu m^m e^{-m}}{\lfloor m+1}.$$

But a more convenient form

$$y = y_0 e^{-P_1} \frac{x}{a_1}\left(1+\frac{x}{a_1}\right)^{P_1} \tag{27}$$

for numerical work is given by Pearson (1914, pp. xlv and 37). These two forms will be equivalent if $p_1 = m$ and $a_1 = \frac{m}{\nu}$. Substituting the values of m and ν gives

$$P_1 = \frac{4}{\frac{1}{\sigma^2} - \frac{4}{n}} - 1 = \frac{4\sigma^2(n+1) - n}{n - 4\sigma^2}$$

and

$$a_1 = \frac{P_1(p-q)}{2}$$

where $\sigma^2 = npq$. In formula (27) the origin is at the mode, hence $x = r - \text{mode}$.

But for Pearson's Type III curve the relation of the mode to mean is (Elderton, 1906, p. 65)

$$\text{Mode} = \text{mean} - \tfrac{1}{2}\frac{\mu_3}{\mu_2}$$

which reduces to

$\text{Mode} = nq + 1 - \frac{p-q}{2}$ for the binomial series. Therefore in formula (27)

$$x = r - nq - 1 + \frac{p-q}{2}. \tag{28}$$

Also the simpler expression

$$\frac{1}{\sqrt{2\pi}\sigma} = \frac{.399}{\sigma} = \frac{1}{\sqrt{2\pi npq}}$$

can be used for y_0 (Merriman and Woodward, 1900, 482). Table IV gives the terms of the expansion of $(.9+.1)^{20}$ computed from the series, and from Pearson's Type III curve.

TABLE IV

TERMS OF THE EXPANSION $(.9+.1)^{20}$ AND THE CORRESPONDING VALUES OF PEARSON'S TYPE III FUNCTIONS

r	x	$\frac{x}{a_1}=X$	$\log_{10}\frac{(1+X)}{e^X}$	$\log_{10} y$	y	Value of terms, computed from the expansion
1	−1.6	−.390	.046	$\bar{1}.001$	.1002	.122
2	−0.6	−.146	.0052	$\bar{1}.420$	.263	.270
3	0	0	0	$\bar{1}.473$	.297	.285
4	1.4	.342	.020	$\bar{1}.268$	.185	.190
5	2.4	.585	.052	$\bar{2}.939$	.087	.090
6	3.4	.830	.098	$\bar{2}.466$	.029	.032
7	4.4	1.073	.149	$\bar{3}.944$	.009	.009
8	5.4	1.318	.208	$\bar{3}.340$	.002	.002
9	6.4	1.560	.269	$\bar{4}.713$	.0005	.0004
10	7.4	1.805	.336	$\bar{4}.025$	.0002	.0001

To illustrate the use of Pearson's formula (equ. 27) compute y when $r=5$. Then $n=20$, $p=.9$, $q=.1$,

$$\sigma^2=20\times.9\times.1=1.8,\ \sigma=1.342$$

$$4\sigma^2=7.2$$

$$P_1=\frac{7.2\times21-20}{20-7.2}=\frac{131.2}{12.8}=10.25,\ a_1=\frac{10.25(.9-.1)}{2}=4.1$$

and

$$y_0=\frac{.399}{1.342}=.2973 \text{ and } X=\frac{x}{a_1}.$$

To find $\log_{10} y$, subtract P_1 times the value of

$$\{\log_{10}(1+X)-X\ \text{Log}_{10}\ e\}$$

found in Pearsons' Table XXVI (1914, p. 37), from $\log_{10} y_0$.

For example, if $r=5$, $x=5-3+.4=2.4$, $X=\frac{2.4}{4.1}=.585$

$$\{\log_{10}(1+X)-X\ \text{Log}_{10}\ e\}=.052$$

$$(10.25)\ (.052)=.534$$

$$\log y_0=\log .2973=\bar{1}.473$$

$$\log y=\bar{2}.939$$

$$y=.087$$

The sum of any number $(r-s)$ of terms measured from the mean is

$$\int_o^x y dx = y_0 \int_o^x e^{-P_1 \frac{x}{a_1}} \left(1+\frac{x}{a_1}\right)^{P_1} dx \tag{29}$$

where $x = r-s+\dfrac{p-q}{2}$;

but tables of this integral are not available.

Edgeworth's (1906) theory of skew variation based on an extension of the methods by which the norman law was derived yields much more convenient formulae than Pearson's more general theory. Tolley (1916) concluded that Edgeworth's (1906) approximate rule (see equation (30)) would suffice for climatic data, and has published convenient tables for its application (Tolley 1916, pp. 640–1).

The total area of the generalized curve between the abscissa x_1 and x_2 is

$$A = \int_{x_1}^{x_2} \left(\frac{1}{\sigma\sqrt{2\pi}}\right) e^{-\frac{x^2}{2\sigma^2}} dx - \left[\frac{1}{\sqrt{2\pi}} e^{-\frac{x^2}{2\sigma^2}} \left(\frac{k}{1\cdot 2\cdot 3}\right)\left(\frac{x^2}{\sigma^2}-1\right)\right]_{x=x_1}^{x=x_2} \tag{30}$$

(Tolley, 1916, p. 638), where

σ = standard deviation,

x = distance (abscissa) from mean, x_m

μ_3 = third moment about the mean

N = total number of observations,

$k = \dfrac{\mu_3}{\sigma_3}$.

For the binomial series (equation 21) on page 611

$$\sigma = npq,\ \mu_2 = npq\ (p-q),\ k = \frac{p-q}{\sqrt{npq}}.$$

If $y = \dfrac{x}{\sqrt{2}\sigma}$, equation (30) becomes

$$A = \int_{y_1}^{y_2} \frac{1}{\sqrt{\pi}} e^{-t^2} dt - \left[\frac{1}{\sqrt{2\pi}} e^{-t^2}(2t^2-1)\frac{k}{6}\right]_{y=y_1}^{y=y_2}. \tag{31}$$

If y_2 equals ∞, $A = A_r$, area to the right of y_1.

If y_1 equals $-\infty$, $A = A_L$, area to the left of y_2.

That is,

$$A_r = \frac{1}{\sqrt{\pi}}\int_{y_1}^{\infty} e^{-t^2}dt + \left[\frac{1}{\sqrt{2\pi}}e^{-y_1^2}(2y_1^2-1)\frac{k}{6}\right] \tag{32}$$

$$A_L = \frac{1}{\sqrt{\pi}}\int_{-\infty}^{y_1} e^{-t^2}dt - \left[\frac{1}{2\pi}e^{-y_1^2}(2^{y_1^2}-1)\frac{k}{6}\right] \tag{33}$$

but

$$\frac{1}{\sqrt{\pi}}\int_{y_1}^{\infty} e^{-t^2}dt = \tfrac{1}{2}\left[1-\frac{2}{\sqrt{\pi}}\int_0^{y_1} e^{-t^2}dt\right],\ y_1 \gtreqless 0 \tag{34}$$

$$\frac{1}{\sqrt{\pi}}\int_{-\infty}^{y_1} e^{-t^2}dt = \tfrac{1}{2}\left[1+\frac{2}{\sqrt{\pi}}\int_0^{y_1} e^{-t^2}dt\right],\ y_2 \gtreqless 0 \tag{35}$$

$$\frac{1}{\sqrt{\pi}}\int_{y_1}^{\infty} e^{-t^2}dt = \tfrac{1}{2}\left[1+\frac{2}{\sqrt{\pi}}\int_0^{y_1} e^{-t^2}dt\right],\ y_1 \lesseqgtr 0 \tag{36}$$

$$\frac{1}{\sqrt{\pi}}\int_{-\infty}^{y_1} e^{-t^2}dt = \tfrac{1}{2}\left[1-\frac{2}{\sqrt{\pi}}\int_0^{y_1} e^{-t^2}dt\right],\ y_2 \lesseqgtr 0 \tag{37}$$

and the "probability integrals" in the second members are given in various tables, *e. g.*, Broggi (1911, p. 354), Czuber (1914, p. 437), Fowle (1914, p. 56), Merriman (1903, p. 220) and Pearson (1914, pp. 9–10). The exponential e^{-y^2} has also been tabulated by various authors, *e. g.*, Fowle (1914, p. 48), or may be obtained from a table of the "probability integral" since

$$e^{-y^2} = \frac{\int_{y-\Delta y}^{y+\Delta y} e^{-t^2}dt}{2\Delta y} = \frac{\sqrt{\pi}}{2}\left\{\frac{\frac{2}{\sqrt{\pi}}\int_0^{y+\Delta y} e^{-t^2}dt - \frac{2}{\sqrt{\pi}}\int_0^{y-\Delta y} e^{-t^2}dt}{2\Delta y}\right\}. \tag{38}$$

For example suppose we wish any term or the sum of any number of terms of the series

$$\begin{aligned}(.9+.1)^{20} &= .122+.270+.285+.190+.090+.032\\ r= \quad & 1, \quad 2, \quad 3, \quad 4, \quad 5, \quad 6,\\ &+.009+.002+.0004+.0001,\\ & 7, \quad 8, \quad 9, \quad 10.\end{aligned} \tag{39}$$

Then,

$$p=.9,\ q=.1,\ n=20$$

$$\text{mean} = nq+1 = 2.0+1 = 3.0$$

$$\sigma = \sqrt{(20)(.9)(.1)} = 1.342$$

$$k=\frac{.9-.1}{1.342}=.596,\ \frac{k}{6}=.0993$$

$y=\dfrac{x}{\sqrt{2}\sigma}=.5268x$, and equations (33), (35), and (37) become

$$A_L=\tfrac{1}{2}\left[1+\frac{2}{\sqrt{\pi}}\int_0^{y_2}e^{-t^2}dt\right]-.0396\,e^{-y_2^2}(2y_2^2-1), \tag{40}$$

for $x\gtrless 0$, and

$$A_L=\tfrac{1}{2}\left[1-\frac{2}{\sqrt{\pi}}\int_0^{y_2}e^{-t^2}dt\right]-.0396\,e^{-y_2^2}(2y_2^2-1), \tag{41}$$

for $x<0$, where the absolute values of y are to be substituted.

Let $x=0$, then $y_2=0$ and Equation (40) becomes

$$A_L=\tfrac{1}{2}+.0396=.5396.$$

Let $x=1.5$, then $y_2=.7902$, $y_2^2=.6244$, $e^{-y_2^2}=.5404$ and Equation (40) gives

$$\frac{1.7362}{2}-.0053=.8628.$$

Let $x=-1.5$, then $y_2=-.7902$ and equation (41) gives

$$\frac{1-.7362}{2}-.0053=.1266.$$

The table of values of A_L published by Tolley (1916, pp. 640–641) can be used to facilitate the work, as illustrated by the following computation of the values already obtained.

As before, k has the constant value .596 for all the terms of the series.

Suppose $x=0$, then from the table

	Tabular entry, A_L,	k
	.53989,	.600,
	.52660,	.400,
Diff.	.01329	.200
Diff.	.00027	.004 = .600 − .596

.53962 = Interpolated value of A_L.

Suppose $x=1.5$, then $\dfrac{x}{\sigma}=1.117$ and from the table

Tabular entry, A_L	value of $\dfrac{x}{\sigma}$

when $k=.6$	.85976	1.10
	.86829	1.15
Diff.	.00853	.05
Diff.	.00289	$.017=1.117-1.10$

$.86265=A_L$, when $k=6.00$ and $\frac{x}{\sigma}=1.117$

Diff. .00003 correction for reducing to $k=.596$.

.8627 Final interpolated value of A_L

Suppose $x=-1.5$, then $\frac{x}{\sigma}=-1.117$ and from the table

	Tabular entry, A_L	value of $\frac{x}{\sigma}$
when $k=0.600$		
	.13109	−1.10
	.11843	−1.15
Diff.	.01266	.05
Diff.	.0042	$.017=-1.10+1.117$

$.12687=A_L$ when $k=.600$ and $\frac{x}{\sigma}=1.117$

.00003 correction for reducing to $k=.596$

.1269 Final interpolated value of A_L.

To compare these results with the exact values given by the series, we must remember that x is counted from the mean term $np+1=3$, as origin and therefore in general (See equation 21), $r=3+x$.

The first two terms plus ½ the mean term $.122+.270+\frac{.285}{2}=.5345$ corresponds to $x=0$, and agrees well with .5396 obtained from the formula. When $x=-1.5$ the sum is simply the first term, .122. The formula gives .127. When $x=1.5$, the sum is the first 4 terms $.122+.270+.285+.190=.867$. The formula gives .863.

In the case of an extremely asymmetrical binomial in which $\frac{q}{pn}$ is very small, the computation of the general term can be most readily

made by means of Poisson's exponential expansion. (Pearson 1914, p. lxxvii and pp. 113–21.) The smaller the ratio $\frac{q}{pn}$, the more closely the terms of the binomial series

$$(p+q)^n = p^n + np^{n-1}q + \frac{n(n-1)}{1\cdot 2}p^{n-2}q^2 + \cdots$$

approximate to those of the exponential series

$$e^{-m}\left(1+m+\frac{m^2}{1\cdot 2}+\frac{m^3}{1\cdot 2\cdot 3}+\cdots\right)$$

$r=$ 1, 2, 3, 4

where $m=nq$. The expression $e^{-m}\left(\frac{m^x}{x!}\right)$ for the $(x+1)$st or rth term is tabulated for $m=.1$ to 15, and $x=0$ to 37 by Pearson (1914, pp. 113–21), thus after computing the constant m for a given case, the successive terms of the series can be read off directly from his table. For example, in the expansion $(.9+.1)^{20}$ already considered $m=nq=(20)(.1)=2$ and the rth term equals $e^{-2}\left(\frac{2^{r-1}}{(r-1)!}\right)$ whose values are entered opposite those of the series in Table V.

TABLE V

TERMS OF THE BINOMIAL SERIES $(.9+.1)^{20}$, AND THE CORRESPONDING VALUES OF POISSON'S EXPONENTIAL EXPANSION

r	$r-1$ equals x	$e^{-2}\left(\frac{2^{r-1}}{\lfloor r-1}\right)$	Terms of $(.9+.1)^{20}$
1	0	.135	.122
2	1	.271	.270
3	2	.271	.285
4	3	.180	.190
5	4	.090	.090
6	5	.036	.032
7	6	.012	.009
8	7	.003	.002
9	8	.0008	.0004
10	9	.0002	.0001

4. REFERENCES CITED.

Blaschke, E.
1906. Vorlesungen über Mathematische Statistik. Leipzig, Teubner, viii+268, 5 figs. in text.
Broggi, Hugo.
1911. Versicherungs Mathematik. Leipzig, Teubner, viii+360 pp.
Czuber, E.
1914. Wahrscheinlichkeitsrechnung und ihre Auwendug auf Fehlerausgleichung Statistik und Lebenversicherung. Leipzig, Teubner, ed. 3, xii+462, 25 figs. in text.
Czuber, E., and Le Roux.
1906. Calcul des Probabilities, Encyclopedie des Science Mathematiques. Paris, Gauthier-Villars, and Leipzig, Teubner, Tome 1, vol. 4, 46 pp.
Davenport, C. B.
1899. Statistical Methods. New York, Wiley & Sons, ed. 1, vii+148, pp., 28 figs. in text.
Deforest, E. L.
1882–3. On an unsymmetrical probability curve. The Analyst., v. 9, pp. 135–142, 161–168; v. 10, pp. 1–7, 67–74.
Edgeworth, F. Y.
1906. The generalized law of error. Journ. Roy. Stat. Soc., London, pp. 69, 497–530.
Elderton, W. P.
1906. Frequency curves and correlation. London, Layton, xiii+172 pp.
Fowle, F. E.
1914. Smithsonian Physical Tables. Washington, Smithsonian Inst., vol. 63, no. 6, ed. 6, xv+355 pp.
Greenwood, jr. M.
1913. On errors of random sampling in certain cases not suitable for the application of a normal frequency curve. Biometrika, 9, pp. 69–90.
Hatai, S.
1910a. Deforest's formula for "an unsymmetrical probability curve." Anat. Rec., 4, pp. 281–290.
1910b. A mathematical treatment of some biological problems. Biol. Bull. xviii, no. 3, pp. 126–130.
1911. The Mendelian ratio and blended inheritance. American Naturalist, 45, pp. 99–106.

Merriman, Mansfield.

1903. Method of least squares. New York, Wiley & Sons, ed. 8, viii+230, 13 figs. in text.

Merriman, Mansfield, and Woodward, R. S.

1900. Higher Mathematics. New York, Wiley & Sons, ed. 3, xi+576 pp.

Pearson, Karl.

1914. Tables for statisticians and biometricians. Cambridge Univ. Press, lxxxiii+143 pp., 5 figs. in text.

1906–07. On the curves which are most suitable for describing the frequency of random samples of a population. Biometrika, 5, pp. 172–175.

Sumner, Francis B.

1910. An experimental study of somatic modifications and their reappearance in the offspring. Archiv für Entwickelungsmechanik der Organisman, 30.2, pp. 317–348.

Tolley, Howard S.

1916. Frequency curves of climatic phenomena. Mo. Weather Rev., 44, pp. 634–642, 4 figs. in text.

Yule, G. Udny.

1911. An introduction to the theory of statistics. London, Griffin, xii+376, pp. 53 figs. in text.

NOTES

ON A NEW METHOD OF COMPUTING FREQUENCY PERCENTAGES

By Robert E. Moritz, *University of Washington*

Suppose there be given the frequencies

$$f_1, f_2, f_3, \ldots, f_n,$$

whose sum is

$$F = f_1 + f_2 + f_3 + \ldots + f_n,$$

and it is required to compute the frequency percentages

$$p_k = 100 f_k / F, \; k = 1, 2, 3, \ldots, n.$$

The method commonly employed is to compute the ratios f_k/F by means of a slide-rule, or, if a slide-rule is not available, to compute the ratio $100/F$ and then multiply, logarithmically or otherwise, each of the numbers f_k by this common factor.

Some time ago, while spending a vacation period at an island camp, the writer unexpectedly interested himself in a statistical inquiry which involved the computation of several hundred tables of frequency percentages. Being deprived of the usual aids in computation, he hit upon the following method of approximation, which, as far as simplicity and rapidity is concerned, makes the usual aids almost, if not entirely, superfluous. Moreover, the writer is now able to show that the results obtained by this method are sufficiently accurate for all practical purposes—the method admitting, in fact, of extension so as to secure any desired degree of accuracy.

The method referred to consists of two steps.

(1) The frequencies f_k are replaced by proportional numbers f'_k whose sum F' approximates 100.

(2) The difference $D = 100 - F'$ is distributed over the numbers f'_k in accordance with the formula $\Delta f'_k = f'_k \cdot D/100$, where $\Delta f'_k$ is that portion of the difference D which falls to f'_k.

It is obvious that when $F' = 100$, there remains no difference to be distributed, and the numbers f'_k are the true frequency percentages. If, however, F' differs from 100, as is usually the case, the numbers f'_k, augmented as directed in (2), will differ slightly from the true frequency percentages, their true values being $f'_k + f'_k \cdot D/F'$, while our formula gives $f'_k + f'_k \cdot D/100$.

We shall illustrate the method by some examples before we consider the magnitude of the errors involved.

In the tables that follow, f_k represents the given frequencies, f'_k the derived frequencies obtained as directed in (1), $\Delta f'_k = f'_k \cdot D/100$, the portions of the difference $D = 100 - F'$ to be added to f'_k and $p'_k = f'_k + \Delta f'_k$, the approximate frequency percentages.

TABLE I

k	f'_k	f'_k	$\Delta f'_k$	p'_k
1	4	6.	+0.06	6.06
2	15	22.5	0.225	22.725
3	23	34.5	0.345	34.845
4	17	25.5	0.255	25.755
5	7	10.5	0.105	10.605
	$F=66$	$F'=99.0$		99.99 (check)

(1) $f'_k = f_k + \frac{1}{2} f_k$. (2) $100 - F' = 1$. $\Delta f'_k = 1\%$ of f'_k.

TABLE II

k	f_k	f'_k	$\Delta f'_k$	p'_k
1	5	6.	−0.05	5.95
2	10	12.	0.10	11.90
3	13	15.6	0.13	15.47
4	24	28.8	0.23	28.57
5	16	19.2	0.15	19.05
6	9	10.8	0.09	10.71
7	7	8.4	0.07	8.33
	$F=84$	$F'=100.8$		99.98 (check)

The results have been rounded off to two decimal places.

(1) $f'_k = f_k + \frac{1}{5} f_k$. $100 - F' = -0.8$. $\Delta f'_k = -\frac{8}{10}\%$ of f'_k.

TABLE III

k	f_k	f'_k	$\Delta f'_k$	p'_k
1	9	5.4	−0.14	5.26
2	24	14.4	0.36	14.04
3	30	18.0	0.45	17.55
4	40	24.0	0.60	23.40
5	31	18.6	0.46	18.14
6	27	16.2	0.40	15.80
7	10	6.0	0.15	5.85
	$F=171$	$F'=102.6$		100.04 (check)

(1) $f'_k = \frac{6}{10} f_k$. (2) $100 - F' = -2.6$, $\Delta f'_k = -\frac{1}{4}$ of 10% of f'_k (nearly).

TABLE IV

k	f_k	f'_k	$\Delta f'_k$	p'_k
1*	18	0.72	+0.005	0.725
2	42	1.68	0.012	1.692
3	85	3.40	0.024	3.424
4	101	4.04	0.028	4.068
5	150	6.00	0.041	6.041
6	202	8.08	0.055	8.135
7	300	12.00	0.082	12.082
8	450	18.00	0.122	18.122
9	373	14.92	0.101	15.021
10	252	10.08	0.069	10.149
11	178	7.12	0.048	7.168
12	120	4.80	0.033	4.833
13	90	3.60	0.025	3.625
14	59	2.36	0.016	2.376
15	50	2.00	0.014	2.014
16	13	0.52	0.004	0.524
	$F=2483$	$F'=99.32$		99.999 (check)

(1) $f'_k=\frac{4}{100}f_k$. (2) $100-F'=0.68=0.7$ nearly. $\Delta f'_k=\frac{7}{10}$ of 1% of f'_k (nearly).

The values of p'_k are correct to three decimal places For many purposes the values f'_k give sufficiently close approximations of the values p_k.

When the method is once clearly understood, the corrections $\Delta f'_k$ need not be tabulated but may be immediately applied to the f'_k's and the results entered in the column p'_k.

Let us now consider the magnitude of the errors introduced into the values of p'_k because of (2). Let p_k represent the true values of the frequency percentages, and let

$$p_k=f'_k+c\cdot f'_k,$$

where c is the fraction of f'_k that must be added to f'_k to obtain p_k. On summing all the values of p_k we have

$$\Sigma p_k=\Sigma(f'_k+c\cdot f'_k)=\Sigma f'_k+c\cdot\Sigma f'_k,$$

from which, since $\Sigma p_k=100$, and $\Sigma f'_k=F'$,

$$100=F'+c\cdot F'$$

that is

$$c=(100-F')/F'.$$

The true frequency percentages are therefore given by the formula

$$p_k=f'_k+f'_k(100-F')/F',$$

while

$$p'_k=f'_k+f'_k(100-F')/100.$$

We may now calculate the error in p'_k, namely,

$$p_k - p'_k = f'_k(100-F')\left(\frac{1}{F'} - \frac{1}{100}\right) = f'_k\frac{(100-F')^2}{100F'};$$

also, the sum of all the errors

$$100 - \Sigma p'_k = \frac{(100-F')^2}{100F'}\Sigma f'_k = \frac{(100-F')^2}{100},$$

and the relative error

$$R = \frac{100-\Sigma p'_k}{100} = \left[\frac{100-F'}{100}\right]^2.$$

The last formula shows that in the case of the four examples given, the relative errors do not exceed 0.0001, 0.00007, 0.0007, and 0.00005 respectively. F' may therefore vary from 100 within much wider limits than in the case of the examples cited and yet yield values of p_k sufficiently accurate for all practical purposes. If F' is anywhere between 95 and 105, the relative error will be less than $\frac{1}{4}$ of 1 per cent. Moreover, it is easy to determine beforehand the limits within which F' must be chosen so as to give any preassigned accuracy to the values of p_k. For example, if the relative error is to be less than $\frac{1}{10}$ of 1 per cent, we have $\left[\frac{100-F'}{100}\right]^2 < 0.001$, from which $96.9 < F' < 103.2$.

STANDARDIZATION OF STATISTICS IN STATE INSTITUTIONS*

By Horatio M. Pollock, *New York State Hospital Commission*

The past half century has witnessed an enormous expansion of state institutions for the care of dependents, defectives, and delinquents. Prior to the Civil War there were in the United States but 24 state prisons or reformatories, 29 state asylums for the insane, and 44 state institutions for other classes. The last were principally schools for the blind and the deaf. The humanitarian movement inaugurated in the early forties by Dorothea L. Dix received new impetus upon the recovery of the states from the ravages of the war, and new state institutions rapidly sprang into being. State boards for the supervision of the several classes of dependents were created, and the policy of state care gradually became established. There are now about 600 state institutions in the United States, housing over 400,000 patients, inmates, or pupils, and representing an investment of over $400,000,000. The

*Read at the Eighty-second Annual Meeting of the American Statistical Association, Atlantic City, New Jersey, December, 1920.

yearly expenditures for the maintenance of these institutions are now upwards of $100,000,000 and are rapidly increasing. Into these institutions are going each year a vast throng of mentally diseased, feebleminded, epileptic, and tubercular patients; blind, deaf, crippled, and orphaned children; delinquent youths and confirmed criminals. In the main, separate institutions are provided for each class.

We can contrast with much satisfaction the work of these state institutions with that of the old county almshouse which in its darkest days was a veritable melting pot of public charity. Into the one almshouse went the poor of all classes—the aged and infirm, the tramp and outcast, the insane, the feebleminded, the epileptic, the blind, the deaf, and the neglected and orphaned children. The zealous overseer, with no qualification for his position except faithful support of his party, was careful to treat everybody alike and thus avoid criticism. The success of this so-called almshouse was measured by its low per capita cost and its high death-rate, although neither was accurately determined. It is indeed a far cry from such a nightmare of poor relief to the modern state hospital for mental diseases, which combines the comforts of a beautiful home with the highest degree of medical care.

Although in establishing its institutions each state has acted independently, the standards advocated by national societies have been generally adopted. There are marked variations in architectural features, but the institutions of the same class in the several states form a fairly homogeneous group.

The advantages to be derived from the coöperation of institutions forming such a group are obvious, but they have never been fully realized. Organizations such as the American Medico-Psychological Association, the American Prison Association, the American Association for the Study of the Feebleminded, and the National Committee for Mental Hygiene have done much to promote and maintain a professional spirit in the management of the institutions and to raise the general standard of treatment. More complete coöperation and coördination are greatly to be desired. In this work statisticians should have a large part. By assisting institutions of the same class in the several states to use a uniform system of records and reports, the statistician makes available for comparison a fund of information that should aid greatly the progress of the institutions and the promotion of the science on which their efficiency depends.

The inmates of state institutions, constituting as they do a great mass of human wreckage, present a challenge to students of society. Here are many sociological problems that should be studied and solved. We should not be content merely to build year after year additional insti-

tutions to house an army of new admissions, but should study the underlying causes of human failure and apply the proper remedies. We must also learn the best methods of restoring the inmates of the institutions to society as efficient citizens. Sociologists, physicians, psychiatrists, psychologists, and statisticians must join hands in an effort to throw light on the many intricate problems here presented. The statistician especially has a large duty in this field in organizing the collected data and analyzing them so that they will indicate the line of remedial action to be pursued.

Prior to 1913 no effort had been made to secure uniformity in classification of patients or inmates, or in the records and statistics of state institutions in the several states. In some states case records of patients were kept, but as the facts recorded were not standardized they were of little value for research and still less for statistics. The first productive effort to standardize statistics in state institutions throughout the country was begun by the American Medico-Psychological Association in 1913 when it appointed a committee on uniform statistics and reports. This committee after prolonged conferences finally presented a report to the Association in May, 1917, in which it recommended a standard classification of mental diseases and a uniform system of statistics for the institutions caring for the insane in the United States. The report was adopted and a special committee was appointed to work with the National Committee for Mental Hygiene in introducing the system in the state hospitals and other institutions for mental disease. The funds to carry on the work were provided by a special appropriation of the Rockefeller Foundation. Statistical record cards and a manual of instruction were provided for the use of institutions, and a standard set of tabular forms was furnished to each institution that expressed its willingness to coöperate in the movement. Marked success has attended the joint efforts of these two organizations and at the present time practically all of the state hospitals for mental disease are using the uniform system.

The improvement of the records and reports of these institutions has given encouragement to national societies working in other fields. In 1919 the National Association for the Study of the Feebleminded appointed a committee on uniform statistics which was instructed to work with the National Committee for Mental Hygiene in preparing a plan for uniform statistics in the institutions for the feebleminded in the several states. At the annual meeting of the association at Cleveland in June, 1920, the committee presented a statistical plan which met with the approval of the association, and an effort is now being made to introduce the system throughout the country. Illinois and New York

have already adopted the plan, and it is probable that it will meet with general acceptance.

Important steps have also been taken to secure better statistics from state institutions for criminals and delinquents. At the annual meeting of the American Institute of Criminal Law and Criminology at Indianapolis in September, 1920, a definite plan for uniform statistics in penal and correctional institutions was adopted, and the secretary of the Institute was instructed to take steps to secure the introduction of the system in the several states. The progressive Department of Public Welfare of the State of Illinois was the first to adopt the new system, but it will probably find favor in many other states.

National associations interested in the care of the epileptic, blind, deaf, and orphaned should take similar action, and the work should be followed up until all state institutions of the same class are keeping uniform records and issuing uniform reports.

At the present time, with the exception of the statistical studies issued by the National Committee for Mental Hygiene, the only nation-wide data relative to state institutions are found in the reports issued at irregular intervals by the Federal Census Bureau. These reports are of great value, but as now constituted they fail to furnish a great deal of information that should be made available each year.

To secure the desired results three lines of action are indicated:

1. The work of standardization of classifications and of records and reports should be completed for all classes of institutions.

2. Central bureaus of statistics should be established by supervising boards in each state.

3. The Federal Census Bureau should receive annual reports from the central state bureaus, and should compile and publish therefrom each year a general statistical review for each class of patients or inmates in state institutions.

If these lines of action were taken and if the statistics were planned to throw light on scientific inquiries as well as on general sociological problems, could we not confidently expect that the data gathered would result in the establishment of more efficacious methods of treatment and the development of better methods of prevention?

A single state institution working by itself is entitled to great credit when it presents the results of its yearly operations and its studies of patients accurately and in good form; the institutions of the same class in one state do better when they use a uniform system of records and combine their annual results into one state report; but the highest value of the data compiled by the institutions will not be realized until the several state reports of each class of institutions are combined into one comprehensive national review.

INTERNATIONAL STATISTICS AND THE LEAGUE OF NATIONS

By Lucien March, *Statistique Générale of France*

The League of Nations is not yet the league of all the nations. The political work connected with the League is a heavy task, fraught with difficulties thickset with sources of division. But other kinds of work enter naturally into its line of business—easier work, capable of joining the good will and raising the thoughts of peoples: that is to say, scientific studies, social work, and all that trends toward the common well-being and the maintenance of peace in the world.

The statistical work may be counted among the lines of work most helpful to the League, and which are besides absolutely necessary to its deliberations. Be it a matter of distribution of population, of public health, production of raw material, international exchange of financial problems—whatever may be the question brought before the League, statistical data, carefully collected and methodically treated, are necessary to add fresh fuel to the discussions and to justify the decisions.

A precise knowledge of the economical and social condition of peoples, their strength and productive power, would be the best guaranty for universal peace, as it would prevent the practice of underhand economical struggles which often are a prelude to political conflicts.

No wonder, therefore, that the Council of the League of Nations, soon after the ratification of the Treaty of Versailles, thought of organizing international statistics for its own use.

I

During the session in Rome in June, 1920, the Council decided to intrust an international commission with a preliminary study of this question. The report of M. Destrée, representative of Belgium, was as follows: "A conference of statistical experts, which met in London last year through the initiative of the Secretary-General of the League of Nations, expressed the unanimous opinion that it would be of great advantage if all the work in the statistical field, whose accomplishment is a necessity in the political life of nations, could be organized on a uniform and centralized system. Any attempt, however, to realize this desirable object raises problems which cannot be solved without the help of experts, both statisticians and persons who make use of statistics. I propose that, to this end, a commission be set up."

The commission was definitely appointed during the session in Saint-Sebastien. It was composed of twelve members, six of whom were representatives of organizations already existent; of these six, two were delegates of the International Statistical Institute, and each of the four others represented one of the following institutions: The International Labor Office, the International Institute of Agriculture, the International Bureau of Commercial Statistics, and the International Institute of Commerce. To these delegates were adjoined four persons in charge of official statistical organizations, and one non-designated representative of Japan.

The commission held a meeting in Paris from the 11th to the 18th of October, 1920, under the presidency of M. Luigi Bodio.* The Secretary-General of the League of Nations had prepared agenda in four paragraphs concerning: (1) the conditions of the international organizations which collect, compare, control, and publish statistics, and the need of a new coördination; (2) the necessity of appointing near the League of Nations a central advisory committee; (3) the relations between the League

* M. Bodio unfortunately survived the fatigue of the journey but a few days.

of Nations and the institutions existent; (4) possible improvement of international statistics and the assistance that could be given by the League of Nations.

Though the above decision of the Council had in no way bound the work of the commission, it has taken for the basis of its work the agenda prepared by the Secretary-General.

But since the commission was appointed by the Council, its task was first of all to enter into the designs of the Council. According to a resolution approved in Rome and sanctioned in Saint-Sebastien, it appeared that the Council wished to dispose of statistics coördinated after a uniform and centralized system. On the other hand, since half the members of the commission were delegates of existing international institutions, the Council evidently desired a close collaboration of these institutions. However, the resolutions of the Council gave no indication whatever that this collaboration was desired. At the session in Rome the Council had decided that the League would pay the "indirect expenses, in other words those incurred by organizations such as the International Labor Bureau and others fulfilling certain special tasks; these bodies work to some extent autonomously, although they depend upon the League of Nations for payment of their expenses."*

A subsidy was granted in that way to the Union of International Associations. Besides, the Council of the League of Nations in Saint-Sebastien adopted an organization of international health similar to the one proposed by the commission for international statistics. However, as nothing either in the resolutions of the Council or in the agenda of the Secretary pointed out clearly that the commission was to study in detail the organization of international statistics, the commission decided to limit its activities to what had been distinctly requested of it, that is, to confine itself to laying down principles and to pointing out the relationships of the existing international institutions to which the Council had reserved a part of influence. It was in this state of mind that most of the members exchanged opinions.

Taking up the first question proposed for study, the commission found that there were a great number (more than a hundred) of international institutions, before the war, which set up, made use of, and compared international statistics. Only a few of them publish statistics regularly. Others occupy themselves chiefly with the methods and the coördination of all the statistics in general. Most of them limit their efforts to the matter in which they are especially interested. The International Statistical Institute belongs to the first class; the International Institute of Agriculture and the other institutions represented in the Commission are examples of those belonging to the second class.

These facts being established, the commission considered its next duty to be to affirm, as heading the advices which it had to send forth, the spirit of collaboration and unification which impregnated the decision of the Council of the League of Nations. In fact, it is not sufficient to extend the field of statistical investigations; it must be made certain first that the field of facts actually observed is intelligently worked on. To that end it is of great importance that the data collected in each country may be relied upon; that their origin and the way in which they have been collected may be exactly known. The methods used in the different countries to collect the statistical facts must also be in sufficient harmony to make the signification of each fact about the same in all the countries compared. Lastly, the classifications in which the numerical facts are arranged must be, if not exactly the same, at least nearly enough alike to give a certain uniformity.

* Official Journal of the League, no. 4, pp. 140–204.

The existing international organizations may usefully bring into coöperation particularly those persons whose studies are conducted in a purely scientific spirit, without being influenced by any material interest.

The commission, therefore, proved:

(1) That there already exists a certain number of independent international institutions which centralize and publish statistics, or which aim at unifying statistical methods and systems.

(2) That it is desirable to avoid overlapping and possible discrepancies in the figures representing the same phenomena.

(3) That the different organizations of the League of Nations find it necessary to handle statistics of various kinds in the execution of their duty, and it is extremely desirable that these various classes of statistical information should be collected on sound and properly coördinated statistical principles.

This point being agreed upon, the commission felt that it could not rely exclusively upon the international organizations; besides, these organizations—according to article 24 of the pact—are no part of the League of Nations.

Taking up the second paragraph of the agenda, the commission advised that an organization be appointed near the Council of the League to give the necessary advices concerning international statistics, and to help the League make the best use of the work already done by the international statistical institutions which keep their autonomy.

Moreover, the desired uniformity of statistics cannot be obtained without long and patient efforts; their imperfections and deficiencies are ascertained only by analyzing them and by trying to draw various conclusions. It would, then, seem to be unnecessary and harmful to await a perfect uniformity before commencing the coördination of international statistics. The reform will surely follow a deliberate and permanent setting to work: the organization which the commission had the authority to bring about may and must become the active agent of this reform.

But it is desirable that this organization ignore all interests except the truth and the scientific value of investigations. In fact, is it not to be feared that some statistics, and especially the methods used to establish these statistics, might be influenced by national tendencies or concerns, or by tendencies of classes of society, all very praiseworthy, which might come into collision, as, for instance, when it is a matter of climatological or epidemiological observations?

The commission desired to bring about this new coördination not only to collect and explain the statistics already compiled, but also to improve and develop these statistics. Now, experience teaches us that it is dangerous to wait for the urgency of events or for some special requirement before thinking of possible developments or progress. It is only by patient and methodical labor of long duration that it is possible to accomplish the work, often considerable and costly, that is required of statistical offices.

Regarding this matter two questions were considered: (1) Would the advisory council establish itself as a center for the statistics of the various countries? (2) How could the desired progress be brought about?

With respect to the first question, the advantage to be gained by the utilization of material already on hand and by the coördination of effort would seem to dictate the policy of appealing to international organizations whenever they could help effectually: and this course was decided upon. Furthermore, the commission asked that if organizations were requested to furnish work curtailing expense, the League of

Nations should pay for the expenditures. We have already stated that during the session in Rome the Council of the League had agreed to do this.

The second question increased the divergence of opinion already mentioned in connection with a preceding resolution. The necessity for studying the means of unifying and improving the methods and the classifications of international statistics was agreed upon; but some of the members thought that the principal part should be left to the Council of the League of Nations, guided by the advices of its Advisory Committee and by the wishes of the International Statistical Institute, whereas others preferred to appoint an additional assembly of statisticians.

It is natural to make use of what exists before creating new organizations. Besides, from the scientific point of view, a private institution, recruited by itself, offers more security for scientific independence than an assembly of persons appointed by the governments. The International Statistical Institute which succeeded in 1885 the former International Statistical Congresses, includes among its members the chiefs of the principal statistical offices, and some learned men who are not connected with these offices but who make use of their work. From what other classes of persons could the members of the new assembly be chosen?

The partisans of an additional assembly have supposed, without doubt, that in the proposed organization the chiefs of statistical offices would be better fitted to prevail upon their governments to institute the desired reforms than when they deliberate in the International Statistical Institute. The commission could not adopt that supposition, however. It held the opinion that motives of a political or a financial order, which in every state stand in the way of the progress of statistics, could be efficaciously opposed only by the Council of the League or by the League itself.

The commission, therefore, advised (1) that the suggestions that were to be transmitted to the different governments should be transmitted through the Council of the League; and (2) that the suggestions from the International Statistical Institute concerning the scientific point of view and the unification of methods should be solicited from the Institute.

Thus, the commission desired that the Council of the League be enlightened by the advisory committee and at the same time by the sole international organization which specially studied the questions of method. In addition, it advised that a copy of the tables that it would use be sent to the International Statistical Institute. The sending of these tables could not be construed as in any way an interference by the Institute with the work of the League of Nations or of the state statistical offices.

To compose the advisory committee the commission proposed to appoint a certain number of representatives from the principal international organizations which establish and make use of statistics. It could not do better than to have represented the institutions which the Council of the League itself had called to advise it. The commission considered it a duty, however, to appoint one more delegate each from the three most important statistical organizations: the International Statistical Institute, the International Institute of Agriculture, and the International Labor Office; and one delegate each from some other international institutions. In addition, a certain number of persons not connected with these institutions may be appointed by the Council of the League. These decisions nearly settled the principal questions, namely, the relations between the League of Nations and the existing organizations, and the assistance that might be given by the League toward the progress of statistics.

But a question was considered that was not found in the order of the day, namely, whether it would not be advisable to determine more exactly the working of the organization which had been created near the League of Nations by the preceding dispositions.

Some of the members desired to specify that the offices of that organization should form a section of the office o˚ the Secretary-General of the League. It has been seen above that at the session in Rome the Council of the League admitted the advisability of intervention of private organizations. Besides, the commission had not been officially advised of any resolution which would justify its interference in the internal organization of the offices of the League of Nations.

Therefore the commission merely pointed out the interest that would be found in the permanence of the work of the advisory committee. It further advised that the Council, which could not have meetings of sufficient frequency, be given authority to delegate its powers, under conditions it should determine, to a permanent committee made up of some five to seven of its members.

II

With the passing of these resolutions, the commission had fulfilled the mission it had been charged to accomplish.

However, it had not treated all the questions that are to be considered in relation to international statistics and their utilization by the League of Nations. The most important of these questions is the centralization of statistics. A non-official commission, which met in London in August, 1918, resolved that question in the negative, on the supposition that the different classes of statistics would be established by different organizations. Later on, the Conference of Statisticians of the United Kingdom and the Dominions advised the contrary, and expressed itself in favor of the entire centralization. It is therefore reasonable to study the question carefully.

In the first place, it is a question that concerns each country individually, as well as a question of international interest; and each country handles it in a different way. In some countries the administration compiles the statistics. In such cases there is often a statistical council formed for the purpose of bringing about a certain uniformity in the views, the methods, and the classifications: sometimes the centralization is entire, and sometimes it exists only for certain classes of statistics.

The first system may support itself by considerations of a practical order. When it is a question of collecting the elementary data of statistics concerning a specified object, it is generally the staff of the department governing that object which collects the data. A central statistical office would not have the same authority over that staff as the department to which it belongs. And, besides, the collecting of data is, as least some part of it, an accessory element of the administrative work itself. For instance, the health administration intrusted with the notation of cases of infectious diseases in order to prepare immediately the efficacious measures to be taken, cannot fail to note the number of those cases. So one may conceive that in a particular state there might be some objections to the centralization of statistics in spite of the advantages which appear especially in an international organization, and which have determined several states to establish it completely, namely, the Netherlands, Canada, Rumania, Poland, Czecho-Slovakia; other countries have for a long time centralized their statistics to some extent.

The objections disappear entirely in international organizations. Except in some special cases, it is no longer a question of collecting elementary data: the chief purpose of the international organization is to coördinate statistics compiled by other

organizations. Now, the statistics include a general technique which suits all the materials used, and a special technique for each material.

If each organization appointed for a particular class of research itself establishes and coördinates the statistics relating to that class, it is absolutely necessary that that organization should comprise an office accustomed to statistical work, able to criticize numerical data received when comparing them or analyzing their differences, and able also to draw out properly their characteristics and the relations derived therefrom. In the same manner, if a central organization is intrusted with the centralization of all the statistics, whatever may be their origin, it will have to be subdivided into groups accustomed to the various kinds of research which require a particular technique to appreciate properly the quality of corresponding numerical results.

For instance, the International Office of Public Health requires mortality and morbidity statistics, and statistics of population generally, in order to measure the danger of certain diseases, to ascertain the results of measures it recommends, etc. It is suitable that the section intrusted with the centralization of statistical data should include some clerks able to discern the characteristics of the diseases, and at the same time able to determine the terms of comparison of gathered data and to appreciate the value of these data—in a word, to utilize them scientifically.

In like manner, in a centralized organization the section intrusted with the statistics relating to the vitality of populations should include some officers able to appreciate the characteristics of that vitality, and to determine the real nature of the diseases and their classification. In this case, the question is reduced to this: It is desirable to incorporate into the health organization or into the central statistical organization the section intrusted with the statistics relating to the vitality and the sanitary conditions of the populations.

But the Public Health office is not the only organization concerned with this class of statistics. The department that studies the population, the one dwelling upon professional matters, an insurance organization, or an emigration bureau will have need of some at least of these statistics. Will it be necessary for each one of them to collect data of the same order, and in many cases, according to different methods?

In short, the question is to know whether the sections intrusted with statistics peculiar to different organizations of the League of Nations shall be placed respectively under different authorities or under the same authority. If the former plan is adopted, each section will have its peculiar tendencies, will endeavor to acquire directly the information it is interested in, under the form that seems to be the most convenient; and it will treat this information according to its own inspiration or that of the director of the organization to which it belongs. Doubtless a central commission would be created where the chiefs of the sections could confer with one another. But experience shows us that a commission is rarely an active body and that it is unsuccessful in overcoming personal tendencies, those of corporations, or the reasons for accommodation.

On the contrary, if the particular statistical sections are placed under one authority, that authority will have but one duty—to cause the rapid compilation, the accuracy, and the uniformity of data. It will be known in every country that an impartial organization, free from any political or administrative aims, or class, school or opportunity tendencies, superintends the elaboration of the statistical data supplied by all nations. Furthermore, the overlapping, and the requests from different sources relating to the same object will be avoided. Lastly, the publications will contain only comparable facts, coördinated and represented with method and in a proper scientific spirit.

For the last few years, the permanent bureau of the International Statistical Institute, which M. Methorst superintends with so much care and intelligence, has been a good example of a useful and scrupulous centralization of statistical data compiled throughout the world.

It is undoubtedly of world-wide interest to enlarge as much as possible the field of international statistics. Through statistics the nations would become more closely united, for they would know one another better. If they are accurate and impartial, statistics are an important element in bringing about reciprocal acquaintance and mutual confidence. They furnish indexes desired by parliaments, books, or the press. But hitherto no admitted authority has given to those indexes the necessary attention, or has determined the extent of their use. Would it not be one of the benefits of the League of Nations if the degree of accuracy were increased concerning the principal facts of international life? And would it not be a benefit to have an organization which, in joining for a common labor the existing international organizations without interfering with their independence, and in unifying the coördination of international statistics, would prevent overlapping, waste of time, and confused methods, and would enlarge the classifications of international statistics?

The commission intrusted by the Council of the League of Nations with the study of the scheme for such an organization has laid down the basis for it, but it has made the plans sufficiently flexible to allow the new body to be harmoniously suited to the other structures of society.

REPORT OF THE INTERNATIONAL STATISTICAL COMMISSION APPOINTED BY THE COUNCIL OF THE LEAGUE OF NATIONS

By R. H. Coats, *Dominion Statistician for Canada*

A reference to the appointment of this Commission appeared in the Quarterly for September, 1920 (page 356). The Commission consisted of representatives of the following bodies, namely, the International Labor Office, the International Institute of Agriculture, the International Bureau of Commercial Statistics (Brussels), the International Institute of Commerce, and the International Statistical Institute, together with the following persons: Lucien March (France), R. H. Coats (Canada), J. de Elola (Spain), Luigi Bodio (Italy), A. W. Flux (Great Britain), and M. Marumo (Japan).

The terms of reference drawn up by the Secretary-General of the League, as interpretive of the minute of the Council of May, 1920, were as follows:

1. To advise the Council of the League of Nations with reference to:
(a) The extent to which the work of obtaining, collating, examining, and publishing international statistics is already carried out by international bodies;
(b) The extent to which the published and unpublished work undertaken by these bodies requires or will require further coördination.
2. To consider and report upon the desirability of instituting a central advisory council on statistics for the purpose of advising the League of Nations concerning the coördination and standardization of statistics, and, further, to report upon the constitution and duties of such a council, should its institution be recommended.
3. To consider and report upon the relationship of the existing international statistical institutions to the League of Nations.
4. To consider in what directions international statistics require further development and in what manner the League of Nations may profitably assist such development.

The discussions extended over eight meetings, with Senator Bodio as chairman. At an early stage a difference of opinion arose as to the scope of the questions submitted

to the Commission, one section regarding its business as limited to the constitution of an international advisory council on statistics, whilst the other (supported by the representative of the League Secretariat) held that the general principles which international statistical organization should follow, and the relation of the Secretariat thereto, should be taken under consideration. These and other differences developed into a Majority and a Minority Report. The resolutions supported by the Majority were as follows:

(1) *Whereas*, there already exists a certain number of independent international institutions which centralize and publish statistics, or which aim at unifying statistical methods and systems;
(2) *And whereas*, it is desirable to avoid overlapping and possible discrepancies in the figures representing the same phenomena;
(3) *And whereas*, the different organs of the League of Nations require to handle statistics of various kinds in the execution of their duty and it is extremely desirable that these various classes of statistical information should be collected on sound and properly coördinated statistical principles;
(4) The Commission is of opinion that there should be instituted by the League of Nations an International Commission of Statistics, the mission of which would be to advise the Council of the League of Nations upon the statistics of all kinds that are necessary for the League.
(5) The Commission is authorized
(a) To advise the League on all technical statistical questions;
(b) To assist the League to utilize to the utmost possible extent the work already carried out by international statistical organizations, and to assist those bodies by its advice to delimit their respective spheres; it would in each case, whenever possible, apply to the international institutions or offices which are concerned with the production of the said statistics, the said institutions to retain their autonomy;
(c) To make or transmit suggestions to the various governments through the Council of the League as to the standardization and improvement of official statistical material.
(6) The statistics produced should be delivered to the International Commission of Statistics in two copies, one of which should be transmitted to the International Institute of Statistics, in view of the suggestions that this institute might formulate from a scientific point of view and with a view to the standardization of methods.
(7) The expenses for statistics supplied at the special request of the commission by the institutes or international offices should be covered by the League of Nations.
(8) This Commission would be composed of 25 members, that is to say:
(a) Three delegates of the International Institute of Statistics and of its permanent bureau; 2 delegates of the International Institute of Agriculture; 2 delegates of the International Labor Office; 1 delegate of the International Bureau of Commercial Statistics; 1 delegate of the International Institute of Commerce; 1 delegate of the International Chamber of Commerce; 1 delegate of the Permanent Committee of Social Insurance; 1 delegate of the International Office of Hygiene; 1 delegate of the Universal Postal Union; 1 delegate of the International Telegraph Office;
(b) The Secretary-General or his delegate.
(c) The other members should be designated by the Executive Council of the League of Nations and should include representatives of the services which make or utilize statistics.
(9) The Commission shall meet whenever it may be considered desirable, or whenever it is convoked by the Council of the League of Nations. It shall meet at least once a year.
(10) In the intervals between its sessions it can delegate its powers to a permanent sub-committee composed of five of its members as a minimum, or seven as a maximum.
(11) It shall itself determine the conditions under which it delegates its powers to the permanent sub-committee.

The Minority Report, which was signed by Messrs. R. H. Coats, Royal Meeker (representing the International Labor office), and A. W. Flux, was as follows:

"The undersigned are unable to agree with the recommendations presented by the majority of the Commission. We are of the opinion that the step now imperatively

needed to unify and standardize international statistics is to establish within the organization of the League a statistical section corresponding to the other technical organizations set up in the League. This the majority of the Commission did not consider to come within the terms of the reference, an opinion with which we are unable to agree, in view of the precise explanations made on behalf of the Secretariat by its representative. If any doubt remained after these explanations, further formal instructions should have been obtained from the Secretariat.

"To the statistical section above-mentioned should be attached an advisory council of statistical experts, corresponding somewhat to the proposals of the majority but differing in essentials. We believe, moreover, that provision should be made for the constitution of a general statistical assembly representing the countries of the world. Especially objectionable do we consider the explicit provision in the plan submitted by the majority for reference by the proposed advisory council to another and a private organization, namely, the International Statistical Institute. Our chief objection, however, is to the putting forward of an advisory council as a body competent to perform the urgent and difficult task involved in the coördination and standardization of statistics. This task, we repeat, can only be carried out by a properly constituted permanent office. In general, we think the report of the majority leaves matters substantially as at the conclusion of the London Conference of August, 1919. In definite terms we recommend as follows:

1. That a statistical section should be set up within the Secretariat of the League of Nations whose duties would be:

(a) To confer with the various sections of the League and other official international bodies as to the statistics required by them and to be collected by them or on their behalf;

(b) To receive from the various sections of the League such statistics as may be collected by them;

(c) To collect from governments or from other sources such additional statistics as may be required;

(d) To publish such statistics as may be thought desirable.

2. That in the execution of these duties the Statistical Section of the League should be assisted by an Advisory Council constituted as hereafter specified, whose duties would be:

(a) To advise the Section on all technical statistical questions;

(b) To assist in utilizing the work of international statistical organizations and to make suggestions with a view to delimiting their respective statistical activities;

(c) To advise the Section regarding the transmission of suggestions through the Council of the League to the various governments for the standardization and improvement of official statistics.

3. The Advisory Council should be composed as follows:

(a) Each of the members of the Council of the League of Nations should be represented by one statistical expert;

(b) Each of the following organizations should have one representative: the International Agricultural Institute, the International Labor Office, the Bureau of Commercial Statistics, and the Institute of Hygiene;

(c) A representative of the International Statistical Institute;

(d) A representative of the Secretary-General of the League who should be chairman of the Council.

4. There should be summoned at such times as may seem desirable, and, in general, at intervals not exceeding three years, a conference representing the statisticians of all nations to express their opinion upon matters of statistical importance. The agenda of such meetings should be circulated four months in advance of the meetings.

"In further explanation of the above, we would add the following suggestions:

"The Statistical Section of the Secretariat should be under a director and also an assistant director (in view of the heavy administrative task) and should otherwise be adequately staffed and equipped. Emphasis should be placed on the technical qualifications of the staff. The director should be the secretary of the Advisory Council.

"It is contemplated that the members of the Advisory Council under section 3 (a) would secure advice in reference to matters under consideration by consultation with the statistical experts of their respective nations.

"The Assembly should consist of a representative from each member of the League accompanied by an adviser or advisers if thought necessary, in order to permit of classes interested in the use as well as the production of statistics. An assembly

should be held within one year of the setting up of the statistical section. The primary object of the Assembly should be to bring international statistics into direct contact with the opinion of statisticians throughout the world, the assemblies and governing bodies of most existing international organizations being gatherings primarily of non-statisticians. On the side of statistical technique the records of the International Statistical Institute are evidence of the valuable results which flow from broad-based discussions; when such results are the product of official as well as private initiative, their practical application, it may be expected, will be more general. The Majority report makes no provision whereby every country may secure a voice in the formulation of international statistical policy.

"In conclusion we would emphasize the opinion that the problem of statistical organization should in the final analysis be approached as an entity, especially in a world-plan which is dependent upon the support of sovereign bodies not disposed to accept confused or wasteful methods, and that there should be recognition at the outset of the character of the working machinery which alone can accomplish that purpose."

The question of procedure offered considerable difficulties. At the end of the sessions the resolutions, as above set forth, were forwarded to the Council of the League, but it was decided that the drawing up of the Commission's report should be carried out by a member of the Majority, subsequent to the adjournment of the Commission, for submission to the individual members for comment thereon. The Minority members thereupon forwarded the statement above quoted to the Secretary-General of the League for presentation to the Council at the same time as the Majority resolutions.

The reports of the Commission were placed before the Council of the League at its meeting in Brussels during October and were by it referred back to the respective governments included in the League.

FRENCH WAR FINANCE

By Faith M. Williams, *Federal Reserve Board*

The Division of Analysis and Research of the Federal Reserve Board has recently completed a study dealing with French war finance. The subject is of especial interest at the present time because of the effect of the French war debt upon present economic and political problems in Europe.

In France's 1920 budget the second largest item of expenditure is that for "the expenses of the public debt" which amounts to almost twelve billion francs. This figure, which is larger than the total French tax receipts in 1919, brought the budget for the "ordinary expenditures" of the French government last year up to almost twenty-two billion francs. In June, 1920, new taxes were enacted which are expected to yield enough revenue to balance this "ordinary budget." There remained, however, after this was done, the expenses connected with pensions, with war-time cost of living bonuses, and with the reconstruction of the devastated regions, which amounted to twenty-six billion francs. Of this amount twenty-one billions were regarded as eventually recoverable from Germany. It was necessary to meet this "extraordinary expenditure" by two internal loans. The 1921 budget contemplates spending 16 billion francs more in the devastated regions, and, in default of any considerable payments by Germany on reparations account, raising that amount by further loans. Since the French public debt now totals about 245 billion francs it does not seem astonishing that the French people do not look upon further additions to their debt with enthusiasm, and that they are very eager for payments from Germany to begin.

France entered the war with a comparatively insignificant internal debt (about 35 billion francs) and with large investments abroad. She begins the year 1921 with a debt at home and abroad which amounts to about 245 billion francs, calculating her

foreign debts at par. A survey of the process by which this debt was piled up makes an interesting study in war finance.

At the beginning of the war the mobilization of almost all Frenchmen of military age completely disorganized the collection of taxes, and French tax receipts for 1914 fell 641 million francs below budget estimates. The invasion of French territory and the occupation of her most profitable industrial region prevented France from floating a great loan at the beginning of the war.

In 1914 her two great sources for current funds were advances from the Bank of France and the sale of three months, six months, and one year Treasury Bills, which were re-named in November, 1915, National Defense Bills. Upon these two sources she depended until 1915. In that year her methods of war-financing developed, and she marketed five and ten year bonds and floated a consolidation loan. By 1916 her system of war finance had been completely evolved. From that time on no new expedients were invented, but the old forms were used over again.

Specifically, seven different sources were utilized to provide funds for the French government during the war. They are as follows:

(1) Receipts from taxes.

(2) Advances from the Bank of France and the Bank of Algeria.

(3) National Defense Bills (Bons de la Defense Nationale, issued first for one year, six months, three months, and later for one month also).

(4) National Defense Bonds (Obligations de la Defense Nationale, five and ten year bonds).

(5) Consolidation Loans. (These loans were all of the "perpetual rente" type except that of the spring of 1920 which matures in 1980.)

(6) Treasury Bills discounted abroad.

(7) Other Loans floated abroad.

France used short term government securities as a means of obtaining war funds much more than has popularly been supposed. Her National Defense Bills correspond to the Certificates of Indebtedness used in the United States and the Treasury Bills of the United Kingdom. They were sold during the entire period of the war, in constantly increasing amounts. The only times when they showed marked decreases were when the Consolidation Loans resulted in the funding of large amounts of the bills outstanding. (The National Defense Bills were accepted as equivalent to cash in subscriptions to loans.) In December, 1919, there were National Defense Bills in circulation to the amount of 46 billion francs, and the latest figure available (that of July 1, 1920) is 44 billion francs. Figures on the amounts floated in the last six months and the amounts paid into the last loan since that time seem to indicate that the bills outstanding in December, 1920, amounted to more than 46 billion francs.

The most striking feature of French war finance is furnished by the advances of the Bank of France to the government, and the consequent increase in its note circulation. It should be observed, however, that at no time during the war did the advances of the Bank of France equal the amounts realized from the sale of National Defense Bills. According to the agreement by which the bank is the only note-issuing body in France, it was required to advance the government, until the expiration of the note-issuing privilege, 200,000,000 francs without interest, and "in time of public emergency" to lend 2,900,000,000 francs at 1 per cent. This was promptly done at the outbreak of the war.

It was evident very shortly, however, that the advances originally agreed upon would not be sufficient for the needs of the state, and in September, 1914, the limit

was raised to 6 billion francs. The maximum was again raised in May, 1915, and it has progressed by successive steps until it now stands at 27 billion francs, not including Treasury Bills discounted for the advances of the state to foreign governments.

The only periods during the war when the advances of the bank decreased were at the time of the Consolidation Loans (December, 1915; November, 1916; very slightly in December, 1917; September, 1918), and at the time of the armistice. The increase in the advances of the bank to the state in 1919 is very striking. There was no great loan during that year to fund the outstanding obligations of the government, and expenditures piled up faster than tax receipts, although the latter were larger than they had ever been before. During 1920, however, the advances of the bank increased very slightly, and during January, 1921, they decreased by about one billion francs.

The advances to the government caused a large increase in the note circulation of the bank. There is no legal reserve ratio for the Bank of France, but the amount of its note issue is limited by act of Parliament. When the war broke out, this limit stood at 6,800,000,000 francs, but it has since been raised several times, and is now 43,000,000,000 francs.

The decrease in the ratio of gold to notes of the Bank of France is not quite so great as the increase in its note circulation would seem to imply, as its gold reserve has increased almost 2 billion francs since 1914. In December, 1913, the gold reserve of the bank amounted to 3,517 billion francs; in December, 1920, it had reached 5,500 billion francs (including 1,948 million francs held abroad).

Gold convertibility in France was abandoned by an act of Parliament in August, 1914. Bank notes were made legal tender, and issued in 5 and 20 franc denominations to take the place of the coin withdrawn from circulation. There has been a very close correspondance between the advances of the Bank of France to the government and the increase in its note circulation during the war. In the last week in January, 1921, the note circulation stood at 37,913 million francs, and the advances to the state at 29,780 million. The difference (6 billion francs) is only slightly more than the entire note circulation of the bank in 1914.

A third feature of French war borrowing which is of especial interest is that which concerns foreign countries. The report of foreign debts given to the French Senate last July lists ten allied and neutral countries from which she received the loans by which she financed her necessary imports. In most of these countries the loans took the form of short term credits and must be repaid within a year or so. In England and the United States the greater part of the advances came from the national treasury and may presumably be allowed to run for a longer period.

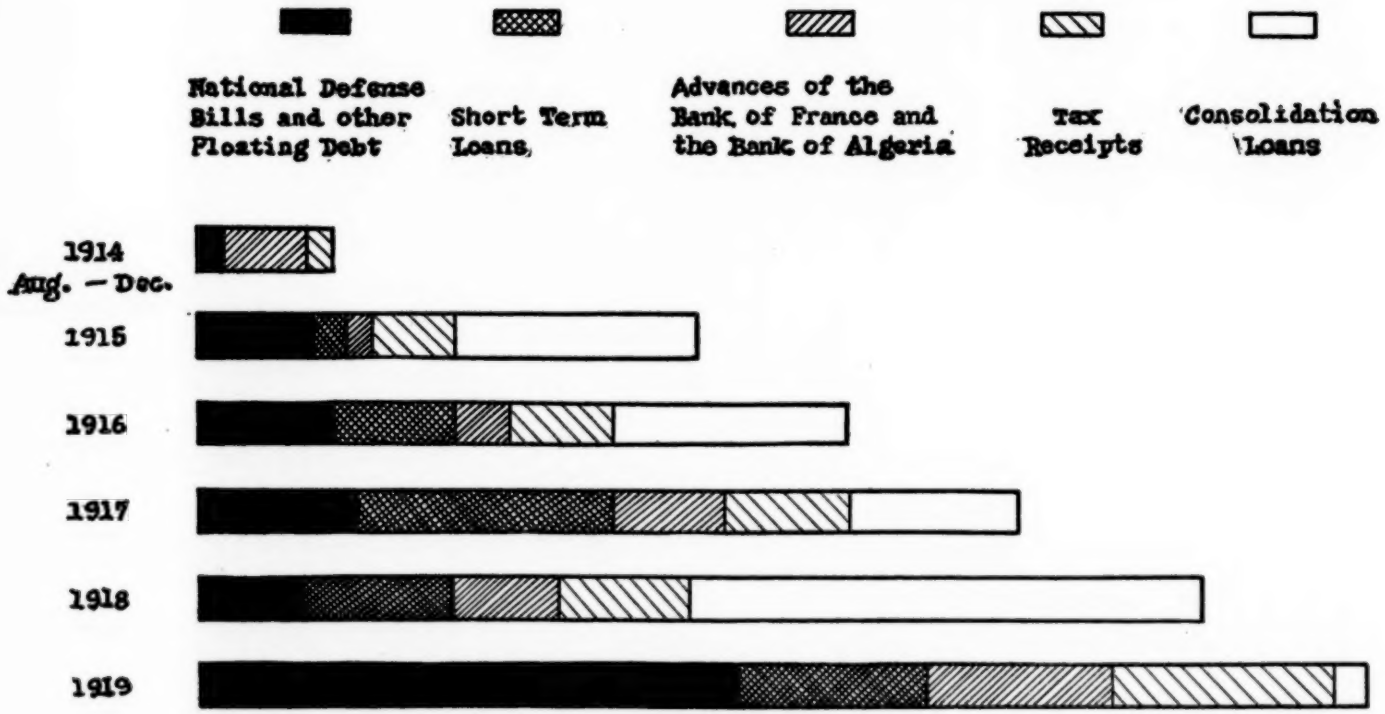
On July 1, 1920, the principal items of the foreign debt were as follows:

FRENCH FOREIGN DEBT AS OF JULY 1, 1920

(In millions of francs)

Bills discounted by the British Treasury	12,327
Bills discounted by the Bank of England	1,639
Advances of the American Treasury	14,428
Anglo-French Loan in the United States	1,295
Bonds given to the American Government in exchange for army stocks	2,072
Short term credit in Spain	593
Other short term credits in neutral countries	954
Other loans	988
Total (all debts calculated at par)	34,296

PRINCIPAL RESOURCES OF THE FRENCH TREASURY



Since the beginning of the war there have been six consolidation loans in France, all but one of them being of the "perpetual rente" type long familiar in France. Only the last loan was issued, strictly speaking, at par, for although interest on the 5 per cent loan of 1920 is paid only on the capital invested, this loan must be repaid at 150 at its maturity. The difference between the amounts actually received in each loan and the amount upon which interest is being paid is shown by the following table.

FRENCH CONSOLIDATION LOANS

(In millions of francs)

Loans	*Nominal capital (face value)*	*Effective capital (amounts paid in)*
5% 1915	15,205	13,308
5% 1916	11,514	10,082
4% 1917	14,882	10,209
4% 1918	31,304	22,163
5% 1920	16,150	16,150
6% 1920	27,000	27,000
Total	116,055	98,912

In order to get a clear picture of the financial operations of the French government during the war, it is profitable to place in parallel columns the resources utilized by the French Treasurer during the five years of the war and the first year after the armistice. The figures for the war years were first published in the 1919 report on the French budget, and those for 1919 were calculated from the figures of M. Klotz, formerly French Finance Minister.*

PRINCIPAL RESOURCES OF THE FRENCH TREASURER

(In millions of francs)

Date	*National defense bills and other floating debt*	*Short term loans*	*Advances of the bank of France and bank of Algeria*	*Tax receipts*	*Consolidation loans*
1914					
Aug.–Dec.	1,124	0	3,900	1,235	0
1915	5,298	1,511	1,175	3,771	10,967
1916	6,244	5,580	2,450	4,641	10,720
1917	7,214	11,709	5,060	5,811	7,670
1918	4,564	7,054	4,780	6,006	23,584
1919	24,542	8,560	8,635	10,000	1,417

* No regular reports are published by the French Treasury, and official figures on French war finance must be obtained from the Documents of the Senate and the Chamber of Deputies. At varying intervals there occur in these Documents statements of the government's financial situation. The statements are sometimes made by the Finance Minister and sometimes by the Chairman of the Senate or Chamber of Deputies Finance Commission. One of the most complete and satisfactory of these reports is that prepared in July, 1920, by M. Doumer who has recently become Finance Minister in the Briand Cabinet.

PROCEEDINGS OF THE 82ND ANNUAL MEETING OF THE AMERICAN STATISTICAL ASSOCIATION

ATLANTIC CITY, N. J., DECEMBER 29–30, 1920

PROGRAM

WEDNESDAY, DECEMBER 29

10.00 A. M.—Morning Session

Topic: Population and Vital Statistics

Paper: Some Recent Morbidity Statistics in Industry, Edgar Sydenstricker, U. S. Public Health Service

Discussion:
William A. Hathaway, American Telegraph and Telephone Co., New York
Willford I. King, National Bureau of Economic Research, New York

Paper: Conduct of the Office and Field Work of the Fourteenth Census, William M. Steuart, Assistant Director of the Census

Discussion:
Raymond Pearl, Johns Hopkins University
Walter Laidlaw, Executive Secretary, New York City 1920 Census Committee

Paper: Standardization of Statistics of State Institutions, Horatio M. Pollock, Statistician, New York State Hospital Commission

Discussion:
Edith M. Furbush, Statistician, National Committee for Mental Hygiene
Eugene B. Patton, Statistician, New York State Industrial Commission

Paper: Work of the Paris Conference on the Revision of the International List of Causes of Death, George H. Van Buren, Supervisor, Statistical Bureau, Metropolitan Life Insurance Co., New York, Delegate of the Association to this Conference called by the French Government, October 11, 1920

2.30 P. M.—Afternoon Session

Paper: Underlying Considerations in Wage Determinations for Industry, William A. Hathaway, American Telegraph and Telephone Co.

Discussion:
William F. Ogburn, Columbia University

Paper: Reduction to Practice of Some Phases of Industrial Medicine, Dr. C. H. Watson, American Telegraph and Telephone Co.

Discussion:
Bernard J. Newman, United States Public Health Service, Washington

Paper: Industrial Education and Training, J. W. Dietz, Western Electric Co., New York

Discussion:
C. R. Dooley, Standard Oil Company of New Jersey

9.00 P. M.—Evening Session

President's Address, George E. Roberts, Vice-President, National City Bank, New York

10.00 P. M.—Smoker

THURSDAY, DECEMBER 30

9.00 A. M.—Business Meeting
Election of Officers, Reports of Committees, etc.

10.30 A. M.—Morning Session

Topic: Index Numbers

Paper: What is the Best Form of Index Number? Irving Fisher, Yale University (Illustrated with lantern slides.)

Discussion:

Ethelbert Stewart, Commissioner of Labor Statistics
Wesley C. Mitchell, New School for Social Research, New York
Warren M. Persons, Harvard Committee on Economic Research, Harvard University
Correa M. Walsh, Bellport, Long Island
Walter W. Stewart, Amherst College
F. Leslie Hayford, Economic Statistican, Du Pont Company, Wilmington, Del.

2.30 P. M.—Afternoon Session

Topic: The National Income and Its Distribution

Paper: A National Money Accounting as the Basis for Studies of Income Distribution, Malcolm C. Rorty, Statistician, American Telegraph and Telephone Company, New York

Paper: Variation in the National Real Income, Edmund E. Day, Harvard University

Discussion:

Carl Synder, Statistician, Federal Reserve Bank of New York
David Friday, University of Michigan
Walter R. Ingalls, Consulting Engineer, New York
Leo Wolman, New School for Social Research, New York
Nicholas Kelly, Assistant Secretary of the Treasury, Washington, D. C.

Minutes of the Annual Business Meeting

Meeting called to order at 9. A. M., December 30, 1920, President George E. Roberts presiding.

Reports were submitted as follows:

Report of the Secretary for 1920

The following report is submitted with respect to the condition of the Association:

Membership December, 1919			869
Additions during 1920:			
New members	210		
Corporate members	4		
Total		214	
* Deductions during 1920		95	
Net gain during 1920			119
Membership December, 1920			988

* Above deductions during 1920 are distributed as follows:

Deaths reported during the year	6
Resignations during year	32
Dropped because unable to locate	21
Dropped for non-payment of dues	36
Total	95

Besides members we have:

Subscribers, mostly libraries	258
Domestic exchanges	21
Foreign exchanges	61
Total members, subscribers and exchanges	1,324

The death of the following members has been reported during the year: O. C. Barber, Edwin M. Bliss, A. F. Estabrook, William H. Gove, George D. Leslie, H. E. Vineberg.

Four numbers of the publications have been issued during 1920, containing an aggregate of 531 pages, as compared with 331 pages during 1919.

Two special meetings of the Association have been held during the year, in April and November. The attendance at these meetings was 72 and 142 respectively.

Respectfully submitted,

ROBERT E. CHADDOCK, *Secretary.*

REPORT OF THE TREASURER FOR 1920

Receipts

Membership dues		$3,182.60	
Sales, single copies of the QUARTERLY		362.29	
Sales, Memorial Volume:			
Sales to members	$143.48		
Sales through Macmillan Co.	253.72		
Total		397.20	
Subscriptions to QUARTERLY		749.89	
Dividends on B. & A. Stock		148.75	
Balance on hand at first of year		659.47	
			$5,500.20

Expenditures

Printing:			
Printing QUARTERLY Publications:			
December, 1919	$501.22		
March, 1920	776.10		
June, 1920	580.70		
September, 1920	460.30		
(Part payment $500 still due)			
Handbook of members	219.62		
Total	$2,537.94		
Other printing expense, stationery, etc.	395.28		
Total Printing		$2,933.22	
Postage		173.55	
Salaries		1,141.65	
Part payment on $1,500 Memorial Volume loan		700.00	
Interest on Memorial Volume loan		80.53	
Expenses, miscellaneous		247.69	
Balance on hand December 21, 1920		223.56	
			$5,500.20

Report on Memorial Volume Fund 1920

Receipts

Balance from 1919	$56.11	
Sales to members at special rate ($3.50)	143.48	
Sales through Macmillan Co.	253.72	
Deficit paid out of general funds	338.89	
		$792.20

Expenditures

Printing circulars	$11.67	
Part payment on $1,500 loan	700.00	
Interest on loan	80.53	
		$792.20

Payable

The Association has $800 loan on account of the Memorial Volume still outstanding with the Corn Exchange Bank, New York. It also owes the Rumford Press $500 for printing, due on the September issue.

Assets

Seventeen shares Boston & Albany R. R. stock deposited as collateral with the Corn Exchange Bank, for Memorial Volume loan. Unsold copies of the Memorial Volume.

Robert E. Chaddock,
Treasurer.

Report of the Auditing Committee

We have audited the accounts of the Treasurer of the American Statistical Association as of the close of business December 20, 1920, and find all disbursements properly accounted for by cancelled checks and vouchers. We have also verified the treasurer's record of receipts and disbursements, as shown by his books, with the cash balance on hand, as shown by the bank statement, and find the same in agreement.

As is customary, we have made no audit of accounts payable and receivable.

Donald R. Belcher,
B. F. Young,
Auditing Committee.

The reports of the Secretary-Treasurer and Auditors were accepted and ordered printed in the proceedings.

Report of the Editor of the Quarterly Publications

The editor outlined the plan, already in progress during the past year, for improving the Quarterly by developing a section on reviews and notes and sources of statistical information, and for keeping the editorial committee more closely in touch with the statistical work being done in various fields. He pointed out that it would be desirable to offer a limited number of reprints, free of charge, to authors contributing to the Quarterly. Suggestions have come to the editor during the year concerning a change of name for our publications. The proposed names were considered and the Association authorized the Secretary to submit to the members of the Association the following names for vote of preference, a report to be submitted at the next annual meeting: Journal of the American Statistical Association; American Statistical Quarterly; American Statistical Review; Statistical Association Quarterly.

Reports of Committees

THE JOINT ADVISORY COMMITTEE ON THE CENSUS

The report of the Joint Committee of the American Economic and the American Statistical Associations was presented and accepted, as printed in the Quarterly Publications for December, 1920. The Association adopted the following resolutions with reference to this report:

In accepting the report of progress of the Joint Committee to advise the Director of the Census, the American Statistical Association desires to record its hearty approval of the policy of eliminating nearly all the text from census publications for the purpose of hastening the appearance of the bulletins and final reports of the Fourteenth Census, a policy adopted by the Bureau of the Census after conferences with the Joint Committee.

The Statistical Association, further, approves the recommendation made by the Joint Committee to the Bureau of the Census that it prepare and publish systematic scientific analyses of the census results in the form of monographs on the more important census topics. These monographs should be prepared by the Bureau of the Census with the coöperation of specialists in the various topics selected for treatment.

The representatives of the Statistical Association are hereby authorized to urge this policy and to express the conviction of this Association that an adequate interpretation of census figures constitutes an essential and in many respects the most significant part of the work upon the census.

REPORT OF THE COMMITTEE ON FELLOWS

Carroll W. Doten, Chairman, reported the agreement of the Committee in electing the following members as Fellows of the Association, as authorized by Article V of the Constitution: F. Stuart Chapin, Roland P. Falkner, Abb Landis, William F. Ogburn, Raymond Pearl, and Ethelbert Stewart.

REPORT OF THE COMMITTEE ON BUSINESS STATISTICS

The Committee on Business Statistics during the past year has continued the activities outlined in its report for the year 1919. The concrete results obtained include the preparation, and practically the final acceptance by the Boot and Shoe Manufacturers Association and the Automobile Chamber of Commerce, of schedules covering the output of boots and shoes and of automobiles. These schedules have also been discussed informally with representatives of the Division of Manufactures of the Bureau of the Census.

The next step following the preparation of these schedules will be to secure, particularly as to statistics of automobile production, the necessary legislative authority and appropriations to enable the Bureau of the Census to undertake the compilations. The pressure of work on the Census Bureau in connection with the 1920 census, as well as the pressure of other business on Congress, has, however, made it seem desirable to withold action in this respect until after the close of the present year. Several consultations have, nevertheless, been held with the officials of the Chamber of Commerce of the United States in order to secure their support for the necessary legislation. It is believed that such support can be counted upon, and that final action should be secured during the winter or spring of the year 1921.

In addition to the preceding activities of the committee, there has been a rather extensive discussion, with the Chamber of Commerce of the United States and various trade associations, of the possibility of securing the setting up of a number of other indices as to which primary compilation would be made by the trade associations.

Efforts along this line offer a promising field for the work of the committee during the ensuing year.

Owing to the increasing interest in statistical research on the part of business concerns, it is the belief of the committee that it should not attempt to cover the entire field of business statistics, but should be known as "The Committee on Business and Production Indices," and a change of title of the committee in accordance with this suggestion is recommended.

REPORT OF THE COMMITTEE ON NOMINATIONS

The report of the Nominating Committee, consisting of Edmund E. Day, Chairman, Joseph A. Hill and N. I. Stone, was presented for final action. The Secretary was instructed to cast one ballot for the nominations as presented. The following officers for the year 1921 were declared elected: President, Carroll W. Doten; Vice Presidents, Ernest S. Bradford, Louis I. Dublin, William M. Steuart; Counsellors, Raymond Pearl, Warren M. Persons, Malcolm C. Rorty; Secretary-Treasurer, Robert E. Chaddock; Librarian, Horace L. Wheeler; Editor, William F. Ogburn.

CHANGE OF MEMBERSHIP DUES

The Association voted to amend by-law two in such a manner as to read, "Each regular member shall pay annual dues of *five dollars*, or *fifty dollars* at some one time, each fellow shall pay annual dues of five dollars, or fifty dollars at some one time, and each corporate member shall pay annual dues of one hundred dollars."

The Association voted to appropriate $600, as provided last year, for securing assistance in the office of the Secretary-Treasurer.

The Association referred to the Board with power the matter of change in the rate of subscription to the Quarterly Publications and of the time when such rate should be made effective.

The Board was instructed to make investigation as to cost of printing our publication and all possible means of reducing printing expenses.

The matter of providing appropriate organization to meet the needs of business statisticians in their fields of research was discussed informally and left to the Board to work out, under the power given by the by-laws, section three, to organize Committees.

ROBERT E. CHADDOCK,
Secretary.

THE CENSUS OF THE ITALIAN POPULATION FOR 1921

In all of the ex-belligerent nations the first census to be taken after the declaration of peace will be of the greatest importance as it will make known, with exactness, the great changes in population caused by the war. But in Italy the next census assumes a special importance because it consecrates the completion of Italian National Unity in the annexation of lands which for centuries have been dear to every Italian heart. The Superior Council of Statistics, at the meetings held from November 20 to 24, defined the regulations according to which this census shall be conducted. It will be started December 1, 1921, and this date will be kept thereafter for future censuses, which will follow at intervals of ten years.

This census will be a purely demographic one for ascertaining the population only. The combining of such a census with that of the industrial census in 1911 did not bring good results; it was therefore deemed advisable by the Supreme Council to

eliminate therefrom the industrial census. In consequence of this decision, other censuses probably will be taken (industrial properties, habitations, etc.) so as to furnish continuous work for the census office, which will thus become a permanent institution instead of a provisional arrangement as in the past. The possibility of economy by the use of calculating machines has suggested the abandonment of the system of individual bulletins for the family schedule. These will probably be done by the Powers machine.

The questions to be asked on this family schedule have not been formulated definitely as yet. At the session of the Superior Council of Statistics a permanent committee was appointed, consisting of Professors Benini, Gini, and Montaro, the Hon. Beneduce, and Dr. Aschiari, directors of the Central Office of Statistics. One of the duties of this committee will be the preparation of the family schedule. The Superior Council will have the final decision, however.

Questions concerning the sick (blindness and deafness) will be omitted, and the gathering of data about the killed in war, the mutilated, the decorated, etc., will be taken care of in the special statistics soon to be prepared by the Minister of War. In place of these questions, a new one will be introduced regarding the number of children borne by each mother, and the date of birth of the first child. The schedule will also include a question concerning the use of the Italian language in the homes of the people. If this question is answered in the affirmative, the reply must be made in the Italian language. This last question has been adopted in order to determine with exactness the number of the population speaking a foreign language within the boundaries of the country.

There will be several other specific questions. The one concerning literacy will ascertain not only whether a person can read, but also what studies he has completed. A person will be asked in what religion he was reared and what religion, if any, he professes then. With this new questionnaire not only persons regularly married (civil and religious) will be recorded, but also those married only by the religious ceremony, as well as those of Common Law unions. These questions are deemed advisable because of the increasing number of these Common Law marriages permitted as legal during the war. It was also considered important by the Council that the census should be furnished with a classification of the professions which would serve as a reliable guide to the people, and would secure uniformity for the judges who direct them.

The Superior Council, in closing, voted that contemporaneously with the population census of the kingdom a census of the colonies (Tripoli, Cirenaica, Eritrea, Somalia) should also be taken, as well as one of all Italians residing in foreign lands. In the accomplishment of this last, two methods will be resorted to: (1) Assistance will be asked of the consular authorities, commercial agencies, emigration inspectors, and coöperative Italian societies in foreign countries; and (2) census enumerators will obtain from the inhabitants of the kingdom the names of their relatives residing in other countries. These and other points of interest will be considered at future meetings of the Supreme Council. The date of the next meeting was to be announced by the first of January, 1921.

C. GINI.

THE INTERNATIONAL LABOR OFFICE

Of considerable interest to the members of the American Statistical Association are the announcements that have recently come to America of the activities and publications of the International Labor Office of the League of Nations whose headquarters

are at Geneva, Switzerland. The regular periodical publications are three: the *Monthly International Labor Review*, the *Bulletin*, and the *Daily Summary*.

The *Monthly International Labor Review* appears in January, 1921, and is to be published in French and in English. "It is to be a scientific tabular publication containing articles, statistics, and information relating to labor and industry of interest and value to employers, workers, and governments. It will contain contributions by well-known economists, employers, and trade union leaders as well as articles prepared in the International Labor Office."

The *Bulletin* is a weekly publication and has appeared regularly since September, 1920, in French and in English, and since October in German. The purpose of the *Bulletin* is to supply information with regard to the activities of the International Labor Organization. "It contains the texts of official documents, reports of meetings of the governing body and the various international commissions (on unemployment, emigration, etc.) as well as general information with regard to the progress of the office. It also contains particulars with regard to the action taken by the different nations, members of the organization, to give effect to the decisions of the Annual Conference."

The *Daily Summary* has appeared since September 1, 1920, and is published in French and in English. It contains brief notes on important current events relating to labor and industry.

Of the irregular periodical publications there are four types: studies and reports, bibliographical series, legislative series, and reports of the International Labor Conference. The studies and reports contain short reports and articles on subjects of immediate importance and fall into the following fourteen series: (a) industrial activity in its relation to questions of labor; (b) economic relations; (c) employment and unemployment; (d) conditions of labor; (e) social insurance; (f) safety; (g) industrial hygiene; (h) conditions of life of the workers; (i) coöperation; (j) protection of women and children; (k) education; (l) agriculture; and (m) questions affecting seamen. Twenty or more of these special reports and studies have already been published. The bibliographical series contain general bibliographical lists of publications, both official and non-official, and special annotated bibliographies relating to particular subjects. The legislative series is a continuation in a new form of the series formerly published by the old International Labor Office at Basle. A good many of the texts of laws, decrees, orders, and regulations affecting labor in various countries have already been published.

The non-periodical publications consist chiefly of special reports which are the results of important special investigations or researches by the International Labor Office. Similar studies made outside the office may also be published. There have already been published special reports on *Labor Conditions in Soviet Russia* and *An Introductory Memorandum on Production*. This latter publication brings into comparison statistics relating to production, prices, transportation, exchange, hours of labor, and kindred matters having to do with labor costs and production per man in several of the more important industrial countries of the world.

FLORENCE NIGHTINGALE CENTENARY

The one-hundredth anniversary of the birth of Florence Nightingale occurred on May 12, 1920. The event was celebrated throughout the United States and Canada by schools of nursing and by medical and public health societies. Emphasis was placed in these celebrations upon the achievements of Miss Nightingale in founding

the profession of skilled nursing, in hospital reform, and in the reorganization of military medicine. It seems fitting that at this time acknowledgment should be made of some of her more important contributions to the vital and social statistics of the nineteenth century.

The more significant lessons from the statistical work of Florence Nightingale can be applied at the present time when our libraries are fairly bulging with volumes of sterile tables and text, the result of the stimulation of registration and investigative activities by various community interests in the past few decades.

Miss Nightingale contributed to the progress of official and private statistics in two important respects: first, in being responsible for a plan of uniform hospital records and statistics, for an attempt to extend the scope of the British Census of 1861 so as to include housing and sickness data, for the outline of sanitary statistics of the British Army, afterward put into effect by Dr. Thomas Graham Balfour, for the schedules and tabular practice of the stational sanitary reports of the Army in India, and for numerous other purely technical procedures in vital statistics; second, she gave a practical demonstration of the *use* of statistics, in the marshalling of tabulated materials, the graphing of essentials, and in the preparation of compelling, result-bringing text. A thorough reading of the report "Notes on Matters Affecting the Health, Efficiency and Hospital Administration of the British Army" is to be recommended to our American students of statistics in order that they may become acquainted with the elements of the Nightingale style,—clearness, force, simplicity, and the special characteristic "humorous subacidity." "Statistics for statisticians" were, to her mind, an abomination. *Analyses* of tabulated facts on sanitation and on the conduct of public affairs were to her a lever for overcoming the inertia of the legislative mind, of smugly buttressed officialdom, and of an amorphous public conscience.

The Nightingale Centenary should direct the attention of American teachers of statistics to the necessity for shifting the point of view of statistical practitioners. There should be greater emphasis upon ends to be served, and less upon ways and means of compiling data. A survey of statistical activity in America today would perhaps show that much of our effort is aimless. There is laborious and expensive endeavor to produce ponderous tomes, and then feverish activity to find a market for the product. There seems to be a need for a statement of the kinds or sorts of facts, of new methods of analysis and presentation, and for style elements, which will bring results other than the cluttering of library shelves. And in the Nightingale style, one detects more or less the influence of Quetelet, of Farr, and of Laplace. Miss Nightingale was an eager student of the great Belgian's work. This suggests that American students of statistics are not taught the significance of the work of these three pioneers of nineteenth century statistical science. It would be perhaps more profitable to abandon some of the precepts of the young American "school" which imitates the German encyclopedists, and get back to Quetelet and Laplace.

M. A. Nutting and E. W. Kopp.

MISCELLANEOUS NOTES

International Eugenics Congress. Following the First International Congress in Eugenics that was held in London in August, 1912, there is to be held a Second International Congress of Eugenics in New York City, September 22–28, 1921. The headquarters of the congress will be in the American Museum of Natural History. The honorary president of the congress is Alexander Graham Bell; the president, Dr. H. F. Osborn; treasurer, Madison Grant; and secretary general, Dr. C. C. Little,

of Cold Spring Harbor, N. Y. The work of the congress is divided into four sections. The first is devoted to studies in human heredity, including also research in the domain of pure genetics in animals and plants, which will throw light upon human heredity. In this section may be received also certain papers on the physiology of reproduction. The second section will consider factors that influence the human family, and the control of such factors; the relation of fecundity of different strains in families, and the question of social and legal control of such fecundity; also the differential mortality of the eugenically superior and inferior stocks, and the influence upon such mortality of special factors, such as war and epidemic and endemic diseases. Mate selection will be stressed. The third section is concerned with human racial differences. Here will be considered the facts of the migrations of races, the influence of racial characteristics on human history, and the teachings of the past with its bearings on the policy of the future. The fourth section will discuss eugenics in relation to the state, to society, and to education. "In each section the Congress will present carefully worked out facts and the immediate and practical conclusions to which they lead." Special stress will be laid upon the results of experimental and statistical research. The importance of the intellectual, social, and economic aspects will, of course, be pointed out in the section devoted to these various fields. All foreign papers should be in the hands of the secretary general not later than May first, and all papers from Canada and the United States not later than June 15. Foreign governments and many universities and learned societies have been asked to send delegates.

Reports on Operating Expenses in Retail Trades. The Bureau of Business Research, Harvard University, during the last year has issued reports on operating expenses in the retail shoe, grocery, hardware, drug, and jewelry trades, and in the wholesale grocery business for the year 1919. Each of these reports gives detailed statistics regarding expenses, profits, stock-turn, and ratios for a few items on the balance sheets of the stores. Similar summaries are to be prepared for the retail jewelry trade, for department stores, and probably for several other trades for the year 1920. The Bureau also is continuing its compilation of comparative prices for staple cotton cloth in the United States, England, India, China, and Japan. The reports for December and January, for example, indicated that at current rates of exchange, prices of staple cotton goods were lower in the United States than in any of these foreign countries. The Bureau plans to add price comparisons for several other markets as soon as reliable price quotations are available.

An Employment Service Study.—A study of public employment in the United States has been undertaken by the Russell Sage Foundation. The general purpose is to gather the experience of this country in planning, organizing, and administering public employment work. The work undertaken groups itself into three main parts. The first part includes the questions which have to do with the general organization and administration of the service. They include, among others, questions as to federal, federal-state, or some other unit of administration; the organization and function of the service from the federal center to the local ends; the status of the service in the federal, state, or local government organization; and the distribution of offices. The second part relates to the administration of the local offices, and the technique of the local service. This includes office layout; the placement process; practice in receiving, registering, interviewing, and referring applicants; forms and blanks in use; and so on. The third part covers the questions regarding the place and function of the service in our industrial life, local and national—what the obstacles are which the

public employment service must meet and overcome if it is to have a healthy and reasonably rapid development, etc. The investigations have been made by Mary LaDame, Leslie E. Woodcock, J. B. Buell, Fred A. King, and Helen B. Russell, nearly all of whom have been employed at one time or another in public or private employment work. Their experience has been gathered in several different sections of the country. The study is under the general direction of Shelby M. Harrison.

New Commerce Classification. The new schedules for the classification of imports and exports of the United States, which it was originally hoped might be inaugurated at the beginning of this calendar year, can hardly be put into effect for another year. The Department of Commerce has been unable to obtain hearings on the bill for the consolidation of the statistical divisions of the Bureau of Foreign and Domestic Commerce and the Customs Division of the Treasury Department, and consequently no additional appropriation for the new classification is yet available. The long delay in securing the hearings has been due to the fact that the bill in which provision for the new classification is incorporated was reintroduced in December as new legislation, and thus had to be referred to the Commerce Committee. When that Committee has approved suggested consolidation of offices, the bill will have to go before the Appropriations Committee for the consideration of the additional funds required to put the classification into effect. There appears to be no prospect of early action. Furthermore, it will be practically impossible to introduce the new schedules this year even if Congress should grant the necessary appropriations during the present session.

Child Labor Turnover. Of special interest to statistical students is the report on child labor recently published by the Children's Bureau.* The methods of analysis familiar in the construction of life tables are applied in this study to the registration statistics of child labor—the granting of employment certificates. A cohort of children born in a single year is followed from the fourteenth birthday, and the increasing proportion of children seeking employment is shown month by month until the sixteenth birthday is reached. Unemployment is studied in a similar manner. The decrease in the rate of new cases of unemployment is brought out month by month as the children's industrial experience lengthens, and the duration of these periods of unemployment is measured. Incidentally, it might be pointed out that this method of analysis of unemployment offers great possibilities in its application to unemployment among adults.

Legitimate and Illegitimate Birth-Rates. A comparative statement of legitimate and illegitimate birth-rates for the principal countries for the period 1907–1914 is given in a recent bulletin published by the Children's Bureau.† The report contains also comparative material as far as available for the various states and cities in the United States, compiled from state reports on vital statistics or from original data. An estimate of 32,400 illegitimate white births for the United States is given for the year 1915, an estimate which may be fairly considered as a minimum statement, in view of the incompleteness of the birth registration and the erroneous registration of illegitimate as legitimate births.

* *Industrial Instability of Child Workers. A study of employment certificate records in Connecticut.* By Robert Morse Woodbury.

† *Illegitimacy as a Child Welfare Problem: Part I. A brief treatment of the prevalence and significance of birth out of wedlock, the child's status, and the state's responsibility for care and protection.* By Emma C. Lundberg and Katharine F. Lenroot.

Local Section of the Statistical Association Established in Pittsburgh. Through the efforts of Professor Donald M. Marvin, head of the Department of Statistics at the University of Pittsburgh, a local section of the American Statistical Association has been organized at Pittsburgh. The local members have elected the following officers: President, Roswell Johnson, School of Mines, University of Pittsburgh; Vice-President, Earl F. Evans, The Graphic Service Company; Secretary-Treasurer, Donald M. Marvin; Counsellors, J. Freeman Guy, Statistician of the Board of Education, S. L. Nicholson, Statistician of the Westinghouse Electric Company.

The death of Signor Luigi Bodio, one of the world's most distinguished statisticians and economists, occurred in Rome on November 2, 1920, within three weeks after his eightieth birthday. Signor Bodio, a senator of the Kingdom of Italy, was president of the International Statistical Institute. He was also honorary sectional president of the Council of State, president of the Superior Council of Statistics, president of the Council of Emigration and member of the Royal Academy "dei Lincei," vice-president of the Italian Geographical Society, Correspondent of the Institute of France (Academie des Sciences Morales et Politiques), Associate of the Statistical Society of Paris, Honorary Fellow of the Royal Statistical Society of London, Honorary Member of the Geographical and Statistical Society of Frankfurt, of the Statistical Society of Berne, of the Statistical Society of Manchester, and of the American Statistical Association. He was also a member of the International Colonial Institute of Brussels. He was a foundation member of the International Statistical Institute which was established in London, England, on the occasion of the Jubilee of the Royal Statistical Society in 1885. He became, in fact, first Secretary General of the Institute at the time when he held the office of Director General of the Statistics of the Kingdom of Italy, his election to this office being especially appropriate in view of the fact that the first meeting of the Institute was held at Rome in 1887. He held the office of Secretary General until the London Meeting of 1905, when, on his resignation, he was elected Honorary Secretary General. After the death, on November 28, 1908, of the President of the Institute, Dr. Karl Theodor Von Inama-Sternegg, at the meeting of the General Assembly at the Paris meeting on July 10, 1909, Signor Bodio was unanimously elected president of the Institute, the late M. E. Levasseur having declined that honor. During the course of his membership of the Institute, Signor Bodio attended all the thirteen meetings of the Institute with two exceptions, and he contributed to the proceedings a large number of reports and papers on statistical subjects, including especially studies relating to statistics of criminality and emigration. He was also associated with the late M. E. Levasseur in his important studies relating to the area and population of the countries of the world. His last public appearance in his capacity as president of the Institute was at the 13th Session held at Vienna, September 9–13, 1913, when the Permanent Office of the Institute was formed, in the direction of which as president he took a leading part. Signor Bodio was a member of the Commission on Statistics set up in 1920 to advise a policy for the League of Nations, and acted as chairman at the meetings of the Commission held at Paris in October, 1920.

Mr. R. H. Coats, Dominion statistician for Canada, returned in November from the meeting held at Paris, October 11–15, of the Commission appointed by the Council of the League of Nations to consider the organization of an international system of statistics under the League. While in Europe, Mr. Coats also attended the meeting of the Governing Body of the International Labor Office, at Geneva, October 5–7, as

the representative of Canada. Mr. Coats was the member for Canada of the British Empire Statistical Conference which sat in London for six weeks during the winter of 1920 (January 20 to February 26, 1920).

The University of Oxford has awarded the Weldon Medal and the Weldon Memorial Prize to Dr. J. Arthur Harris of the Station for Experimental Evolution of the Carnegie Institution of Washington in recognition of his work in statistical biology. This prize may be awarded every third year ". . . without regard to nationality, sex, or membership of any university, to the person who, in the judgment of the electors, has, in the six years next preceding the date of the award, published the most noteworthy contribution to Biometric Science, in which either (i) exact statistical methods have been applied to some problem of Biology, or (ii) statistical theory has been extended in a direction which increases its applicability to problems of Biology. Biology shall, for the purposes of this clause, be interpreted as including Zoölogy, Botany, Anthropology, Sociology, Psychology, and Medical Science."

Professor Raymond Pearl, head of the Department of Biometry and Vital Statistics and director of the School of Hygiene and Public Health of the Johns Hopkins University, has been awarded the decoration of Knight of the Crown of Italy by the King of Italy. Beginning December 1, Professor Pearl gave a series of lectures at the Lowell Institute in Boston on the "Biology of Death." These lectures will be published later in book form.

Mr. Paul W. Garrett, formerly connected with the American International Corporation, is now with the financial department of the *New York Evening Post*.

Mr. R. von Huhn has been appointed chief statistician of the Edison Storage Battery Company at West Orange, New Jersey.

Mr. Robert Henderson, formerly actuary for the Equitable Life Assurance Society of the United States, has been made second vice-president of the company.

The Committee on the Mathematical Analysis of Statistics of the National Research Council is working on a handbook on statistical methods which will soon be published. The committee consists of Doctors Rietz, Glover, Huntington, Kelly, Pearl, and Persons.

The United States Life Tables for 1890, 1901, 1910, and 1901–1910 are now in the press and probably will be available within the next three months.

Professor Donald M. Marvin, of the School of Economics of the University of Pittsburgh, has been made head of the new Department of Statistics established by the university. Professor Marvin is developing a laboratory for training in statistical methods and their application.

APPOINTMENTS ON COMMITTEES FOR 1921

At a meeting of the Board of Directors on January 22, 1921, in New York City, the following appointments were made:

Associate Editors: Edmund E. Day, Louis I. Dublin, Wesley C. Mitchell, Horace Secrist, Leo Wolman; Assistant Secretaries: E. A. Goldenweiser for Washington,

Martin J. Shugrue for Boston; Library Committee: Edmund E. Day, Chairman, Roswell F. Phelps, Horace L. Wheeler; Finance Committee: George E. Roberts, Chairman, Carl Snyder, Robert E. Chaddock; Membership Committee: Arthur R. Burnet, Chairman, Leonard P. Ayres, Earle Clark, Lawrence K. Frank, Donald M. Marvin; Committee on Business and Production Indices: Malcolm C. Rorty, Chairman, Leonard P. Ayres, Donald R. Belcher, Earle Clark, Edith M. Miller, Warren M. Persons, Carl Snyder.

In addition to these Committees the Board authorized the formation of three new committees as follows: Committee on Institutional Statistics, Committee on Statistics of Marriage and the Family, Committee on Sales Research. The personnel of these committees will be announced in the June issue.

NEW MEMBERS ELECTED SINCE AUGUST

Corporate Membership

Russell Sage Foundation, 130 E. 22nd St., New York City.

Regular Membership

Armstrong, George W., care of Sommons-Boardman Pub. Co., 2201 Woolworth Bldg., New York. Market analysis of railroad purchases.

Beauregard, Joseph E., Narragansett Electric Lighting Co., Providence, R. I. Statistician.

Begen, Owen J., Investment Department, Prudential Ins. Co., Newark, N. J.

Blanchard, Ralph H., School of Business, Columbia University, New York.

Buchaca, Emilio J., Manager, Commercial Research Department, H. H. Franklin Mfg. Co., Rochester, N. Y.

Burger, Magdalen H., Chief Statistician, Baltimore Alliance of Charitable Agencies, 625 St. Paul St., Baltimore, Md.

Cockett, Arthur, Famous Players-Lasky Corp., 485 Fifth Ave., New York.

Cox, Mary de, Librarian, American Tel. & Tel. Co., 195 Broadway, New York.

Creel, H. G., Southwestern Advertising Co., Oklahoma City, Okla.

De Maris, William F., Cost and Sales Department, New England Confectionery Co., 253 Summer St., Boston, Mass.

Fischer, Harry S., Public Service Commission, 49 Lafayette St., New York City.

Fisher, Arne, Statistical Department, Western Union Co., 195 Broadway, New York.

Florence, P. Sargant, U. S. Public Health Service, Washington, D. C.

Freeland, W. E., Sales Engineer, Winchester Repeating Arms Co., New Haven, Conn.

Fry, C. Luther, Industrial Bureau, Merchants Association of New York, 233 Broadway, New York.

Gottlieb, Louis R., Director, Subscribers Inquiry Department, Financial Weekly, 58 W. 39th St., New York.

Gould, Kenneth M., Editor, Social Hygiene, American Social Hygiene Association, 105 W. 40th St., New York.

Greenwood, Ernest, International Labor Office, 618 17th St., Washington, D. C.

Hammond, C. B., Research Department, Acme Wire Co., New Haven, Conn.

Heeren, Ernst G., Statistical Department, Edison Storage Battery Co., West Orange, N. J.

Helburn, J. W., Helburn-Thompson Co., Salem, Mass.

Janow, Barney, Chief Accountant, Nat'l Cloak & Suit Co., 207 W. 24th St., New York.

Jones, Charles E., Installation of Graphic Methods, Ernst & Ernst, 27 Cedar St., New York.

Kaufman, Elmer E., Agricultural Statistician, California Bureau of Crop Estimates, 508 Custom House, San Francisco, Calif.

Kester, Roy B., Department of Accounting, School of Business, Columbia University, New York.

Kucera, Joseph A., President, National Process Co. Inc., 117 E. 24 St., New York.

Lauck, William Jett, Economist, 712 Southern Bldg., Washington, D. C.

Lemon, Freda, Head of Statistical Department, Warner Sugar Refining Co., 79 Wall St., New York.

Masseck, C. J., Director of Sales, The Capper Publications, Topeka, Kans.

Melville, Andrew H., Director of Research, Nast Publications, 19 W. 44th St., New York.

Meyerson, Hyman, Statistician, Bureau of Statistics, Labor Department, Capitol, Albany, N. Y.

Miller, Elliott S., Famous Players-Lasky Corp., 485 Fifth Ave., New York.

Morse, Lawrence P., Director of Research, Babson's Statistical Organization, Wellesley Hills, Mass.

Odell, Frank G., Director of Research, The Capper Publications, Topeka, Kans.

Patton, Eugene B., Chief Statistician, State Industrial Commission, Albany, N. Y.

Perlman, Jacob, Statistician, Bureau of Statistics, Labor Department, Albany, N. Y.

Schutt, Kate M., Federal Reserve Bank, New York.

Smith, Charles Gordon, in charge of Workmen's Compensation Bureau, New York State Insurance Department, 165 Broadway, New York.

Thomas, Arthur C., Publicity Director, Chamber of Commerce, Omaha, Neb.

Wells, Alton L., President, American Institute of Medicine, 13 E. 47th St., New York.

Williams, Faith M., Division of Analysis and Research, Federal Reserve Board, 37 Liberty St., New York.

REVIEWS

Mental Aspects of Delinquency. By Truman Lee Kelly. University of Texas, Bulletin No. 1713, March 1, 1917.

This bulletin contains a scientific study of 296 boys who have been committed to the State Juvenile Training School at Gatesville, Texas. The ages of the delinquents studied vary in general from 10 to 19 years. The anthropometric data obtained relate to the height, weight, lung capacity, head measurements, scars on the head, and the stage of pubertal development. The sensory-motor data secured relate to the strength of vision, astigmatism, acuteness of hearing, disease or malformation of nose and throat, strength of grip, handedness, and speed of tapping. The mental data collected were secured by the Binet test, construction ability test, and the completion test. By combining the results of these three tests the developmental age of each boy was ascertained. The school grade reached by each boy was also considered in measuring his mental status. The distribution curve (normal probability curve) for the Gatesville boys has been superimposed upon a corresponding curve for normal boys in all the measurements where standard norms were available. The medians for delinquent boys are compared graphically with corresponding medians for normal boys, the per cent of delinquent boys above or below the median for normal boys being indicated on each diagram.

When the anthropometric measurements of Gatesville boys are compared with those of normal boys, it is shown that 52 per cent of the delinquent boys are above the median for the height of normal boys. The Gatesville boys also excel normal boys in weight, almost 64 per cent of these delinquents falling above the normal median. In vital capacity also these delinquents excel normal boys, over 59 per cent having a greater lung capacity than the median for the normal boy. With reference to pubertal development, the author finds that the Gatesville boys are inferior to normal boys, only 23 per cent having reached the stage of development attained by the median normal boy of equivalent age. The author finds a close agreement between pubertal and mental retardation, although no coefficients of correlation have been computed. In sensory-motor tests the delinquent boys were found to be inferior to normal boys, but in the following points they were above the median normal boy:

Grip of right hand	40 per cent
Speed of tapping	38 per cent

Unfortunately, no data for normal children were available with which to compare such physical defects as strength of vision, degree of astigmatism, acuteness of hearing, and defects of nose and throat. It was found that 37 per cent of the boys had defective vision and that in most cases it had gone both "undetected and uncorrected." The author states that "eye strain, school failure, truancy, and delinquency represent the history of nearly all of this 37 per cent" and suggests that defective vision may be partly responsible for juvenile delinquency. The author believes that children's eyes should be examined and that glasses should be provided at public expense as a preventive for much delinquency. With regard to hearing, only 10 per cent of the Gatesville boys were found to be defective.

The mental status of delinquent boys was found to be greatly inferior to that of

normal boys. The following percentages show the proportion of such boys reaching or excelling the mental status of the median normal boy:

Binet test	21 per cent
Construction ability test	18 per cent
Completion test	7 per cent
Developmental age (average of three preceding tests)	10 per cent

The author does not consider the Binet test (a test of perceptual ability) to be very reliable since it does not apply to those delinquents whose mental development is above that of a normal child 12 years of age. The constructive ability test (by Kelley) consists in constructing some object out of material supplied by the examiner. The boy must decide upon the object to be made and construct it in accordance with the building material at his disposal. To score high on this test the boy must possess ability in inductive reasoning. Success in this test is not incident to school training. In the case of the completion test each inmate was asked to fill blanks in sentences—in short, to select such words as would make good sense and complete the sentence. In this test the problem has been definitely set, but the solution of it depends largely upon the boy's education and his lingual ability. These three tests, therefore, measure the perceptual, the reasoning, and the verbal ability of the boys. A combination of the three tests forms, therefore, a very reliable index of the boy's mental ability in comparison with that of normal boys. In general, as shown above, only 10 per cent of the delinquent boys are mentally equal to the "average" normal boy of equivalent age.

When the Gatesville boys are compared with boys in the Salt Lake City schools, they are found to have made relatively little school progress. Less than one per cent of these delinquent boys have reached the school grade attained by the average boy of the same age in Salt Lake City. It is quite apparent that these juvenile delinquents do not have the educational equipment possessed by normal boys. The author attributes a part of this deficiency to the fact that Texas had no compulsory attendance law until 1916, and consequently these juvenile offenders were not kept in school. It is rather unfortunate that the author should have compared the educational status of boys chosen from both rural and urban communities with that of normal boys living wholly in the city. The unreliability of the comparison is practically established when it is recalled that Texas boys had not been required to attend school, while the boys in Salt Lake City had been compelled to attend school regularly. Why such a norm should be selected, when an age-grade census for the whole State of Texas was available in 1916, is scarcely explainable.

Expressing the percentile relationships for the various measurements in terms of years of acceleration, it is found that the average Gatesville boy in height is 0.11 years in advance of the normal boy; in weight, 0.42 years in advance; and in vital capacity 0.66 years in advance. For all other measurements made, the average delinquent boy is retarded more than the normal boy by the following amounts: In grip of right hand, 0.45 years; in grip of left hand 0.42 years; in rate of tapping, 1.39 years; in Binet age, 2.18 years; in construction ability, 5.91 years; in completion test ability, 4.43 years; in developmental age, 3.65 years; and in school grade, 4.58 years.

The author has practically established his contention that "mental immaturity coupled with maturity in other lines, physiological, emotional—*i. e.*, development of likes and dislikes, sensitivity to ridicule, success, failure, etc.—gives the groundwork for misconduct," since, in general, delinquent boys are above the average in physiological development but considerably below the normal boy in mental attainment.

Although the complete history of each boy was not known, yet the author attributes delinquency largely to heredity. He asserts that "poverty and neglect pave the way toward delinquency and that low mentality starts the boy down it and keeps him on it."

It is shown that 25 per cent of the boys in the training school are feeble-minded, if feeble-mindedness be defined as consisting of those who are possessed of a mental age below 12 and are four or more years retarded as determined by the Binet test. The author recommends that a state board be established, such board to consist of a specialist in psychology and education, a physician and alienist, and a vocational director, who would decide upon the kind of education that the juvenile offender should receive and the kind of work in which he should engage after being paroled or dismissed from the reformatory, and also to determine who should be considered delinquent and who feeble-minded or insane. This board would have sole authority to determine fitness for pardon, parole, or final release from the state institutions. The court is qualified only to pass judgment as to whether an offender should be removed from society at large—not to determine degrees of mental ability or inability, nor to prescribe proper treatment therefor. The author also suggests that the period of commitment to the juvenile training school be made indeterminate in every case, so as to insure society from the further depredations of those delinquents who are unable to look after themselves with prudence enough to keep out of trouble, or who have not received sufficient training to enable them to become self-supporting individuals.

The graphic work in the study should have been more carefully planned and executed. The normal probability curves for normal and delinquent boys are mere skeleton outlines with no scale for either the ordinate or the abscissa axis. These curves permit of only one comparison—the percentage of delinquent boys above the median normal boy. It is very difficult to ascertain the method employed in determining the vertical scale for the percentile charts in which the standing of Gatesville boys is compared with that of the normal boy. The percentiles have not been equally spaced, thereby tending to exaggerate the relative positions denoting extreme excellencies and deficiencies. The result gives an erroneous notion as to the mental ability of Gatesville boys. This graphic presentation does great injustice to positions far away from the median or 50 percentile line. In fact, the diagram is rather a cartogram or pictogram than a graph possessing mathematical properties.

Another error in method should be pointed out. An attempt has been made to secure index numbers for pubertal development for the various ages by averaging directly the index numbers for 1,317 country boys with those for 3,600 city boys. No account has been taken of the fact that almost three times as many city boys as country boys enter into the make-up of the final averages with which Gatesville boys are compared. The results, however, are not materially affected by this error in computation.

The author inveighs against a lack of coöperation between the home, the school, the juvenile court, the reformatory, and the penitentiary. At present each assumes a shifting responsibility, each passing the problem of delinquency along to the next organization for correction. No records have been kept of individual boys to show conditions which may have caused or contributed to delinquency. The author has prepared five blanks on which valuable information should be recorded. He fails, however, to suggest the proper machinery for carrying his plans into effect. There is no assurance that society will have kept a record of all future Gatesville boys to such an extent that causal relationships may be traced and delinquency diagnosed.

The author recommends that the superintendent of the training school be chosen primarily because of his fitness as an educator and disciplinarian, and secondarily for his ability as a business man and a farmer, and that he should have a long tenure of office. As long as the superintendency is subject to political consideration, just so long will it be impossible for the superintendent to know the history of his boys, to appreciate their aspirations, and to be sympathetically concerned about their future welfare. Above all others, the delinquent boy needs some one who takes a paternal interest in him—one to whom he can look for fairness and intelligent guidance.

H. R. Bonner.

U. S. Bureau of Education.

Profits, Wages and Prices. By David Friday. New York, Harcourt, Brace & Howe, 1920. Pp. v, 256.

This little book, with its fresh and concrete treatment of questions which interest every one, is enjoying a well-deserved popularity. Statisticians have a special reason for reading it, for Professor Friday cultivates that quantitative type of economic theory for whose development they hope.

Several years ago Professor Friday began to use his connection with a firm of public accountants to study the profits of business enterprises with special reference to corporate savings. When the United States entered the war, he put his results at the disposal of the Treasury. Presently he was asked to enlarge the scope of his inquiries and to estimate how much the country could pay in taxes and how many billions it could lend in government bonds. In working for the Treasury, Professor Friday had access to all the relevant data in possession of the government bureaus, and opportunity to have his estimates criticised by the best informed men in financial circles, official and private. After the armistice, he returned to the University of Michigan and had leisure to combine with his own materials the information at every one's disposal. As a result of these varied experiences, he doubtless knows more than any one else about certain aspects of the economic history of the United States during the war.

The topics which he discusses in this book include the fluctuations of profits, interest, and wages during the war, the revolution in prices, the financial plight of public utilities, and the desirability of maintaining income and excess profits taxes at their present high levels. Instead of attempting to digest his conclusions on all these topics, I shall merely give a sample or two to show the kind of results at which he arrives. The first sample shows how that familiar fiction of economic theory, the normal rate of profits, is transformed when squarely faced by a statistician.

"The most that can be said for the normality of profits is that the amount of capital that earns the average rate of profits will remain a fairly constant percentage of all capital. Also, that the amount of capital that earns less than the average rate or more than the average remains about the same one year with another. But the average itself is highly variable and the diversity of earnings for individual establishments is enormous even in so conservative and steady a business as banking" (p. 45).

The next quotations give certain interesting quantitative conclusions.

"It is no exaggeration to say that not more than one-fourth, and probably not more than one-fifth, of the whole volume of corporate profits was actually spent by the stockholders of these concerns. The other 80 per cent went for taxes, for loans to finance the war, and to furnish the funds for industrial expansion" (p. 68).

DISTRIBUTION OF VALUE ADDED BY MINING, MANUFACTURING, RAILROAD, AND PUBLIC UTILITY CORPORATIONS

1913–1918

(In Percentages)

Year	Total value added	Wages	Taxes	Interest	Dividends	Surplus less deficit
1913.....	100.0%	63.9%	3.8%	8.9%	18.5%	4.9%
1916.....	100.0	56.6	4.0	6.0	14.3	19.1
1917.....	100.0	54.3	11.5	3.8	15.0	13.4
1918.....	100.0	61.0	13.7	5.4	11.7	8.2
1919.....	100.0	70.2	9.0	5.0	11.1	4.7

"These figures, without doubt, show pretty accurately the division of the product of these industries and the tendency of the respective shares of labor, capital and the state to increase or decrease" (p. 124).

Practically the most important and statistically the most doubtful of Professor Friday's conclusions concerns the "enormous increase of production over consumption" (p. 91) which he says "made possible" our "feats of war finance." From his belief in this increase he derives the optimistic view ". . . that we have such a reserve of productive capacity in this country that the possibility of raising the real wages of labor to the point where the means of well-being shall be realized for all classes remains no longer a mere dream. It has become a possibility" (p. 235). To realize this possibility he makes a practical suggestion which promises to attain wide celebrity. National production is now kept down by the frequent occurrence of dull times.

"The fundamental reason why production is retarded when only low profits are in sight is that a situation which yields small profits is one in which the prices of products and those of cost goods are close together. . . .

"The factor that prevents a full realization of our productive capacities is this risk of loss. . . . It is pertinent, therefore, to inquire into the possibility of decreasing industrial risk through formal organization. . . . If it were possible to guarantee every entrepreneur at least his operating expenses, including depreciation, the risk of loss would be minimized.

"Such a guaranty could be made only by the government, for it alone can exercise the taxing power necessary to take from the more fortunate industries those fortuitous profits which are the obverse of the losses incident to the modern industrial process. . . ." (pp. 246–8).

I do not think the merit of this suggestion is seriously compromised by rejecting Professor Friday's view that the war caused an extraordinary increase of production. What statistical information we have regarding the physical volume of output during the war—such as the index number of the volume of raw materials produced in 1913–1918 (published in the Summary of the War Industries Board's *History of Prices During the War*), the index numbers of agricultural and mineral products, compiled by Professor E. E. Day for the *Review of Economic Statistics*, the various series made by Mr. Carl Snyder for the Federal Reserve Bank of New York, and the index of production presented by Professor W. W. Stewart before the recent meeting of the American Economic Association—all indicates that the increase in productivity during the war differs little if any from that characteristic of the piping times of peace. The true state of affairs, indeed, is suggested by Professor Friday himself in a different passage. On page 134 he says "1916 saw a material increase in productive output in this country" (just such an increase over 1914 as we expect

to find between the output of a very dull and a highly prosperous year). "This was further augmented in 1917 [though by a narrow margin] and was pretty well maintained during 1918."

This point is not the only one in the book to which exception may be taken on statistical grounds, though the other points are less important. Even when we differ from Professor Friday, however, we remember with gratitude that he is writing the kind of economic theory that deals with facts, the kind that is definitely right or definitely wrong, the kind that is capable of cumulative development if the rest of us in criticising imitate his use of quantitative methods.

Wesley C. Mitchell.

New School for Social Research.

Trends of School Costs. By W. Randolph Burgess. New York, Russell Sage Foundation, Department of Education. 1920. Pp. 139.

Trends of School Costs undertakes an analysis of the trends of teachers' salaries and school-building costs in the United States from 1841 to 1920. Other elements of expenditure for public schools are given little attention on the ground that the items are scattered, and constitute, when combined, only about one-fifth of total school costs. Index numbers for the full period from 1841 to 1920 are developed for the weekly salaries of men teachers and women teachers, both in city and in country schools. An index number for building costs is obtained for the period 1913 to 1919. Teachers' salaries are compared with the cost of living and with the wages of laborers and artisans, and trends are computed for all the more important series. The conclusion is reached that the school budget of 1915 must be doubled in 1920 if pre-war standards of public school education are to be maintained.

The conclusion that school budgets must be greatly increased leads Mr. Burgess, in the final chapter, to consider possible sources of income for the support of public education. He points out that nearly four-fifths of current school revenues are derived from local taxation, and that two-thirds of local revenues are obtained from the general property tax. To meet the doubled school budgets now required, municipalities must do more than reapportion their current expenditures. Large additional revenues must be raised. Mr. Burgess expects such revenues to be obtained principally from increased taxes upon real estate. "The real estate tax is a sound method of taxation, and, in spite of large increases in the tax rate of recent years, there are no indications that the rate which real property can bear has been reached."

In arriving at this conclusion, Mr. Burgess is traveling from the problems of education far afield into difficult questions of public finance. Possibly his conclusions regarding prospective sources of enlarged city revenue are consequently not to be taken too seriously. Certainly there can be no adequate discussion of municipal resources without a careful examination of the possibilities of increased local revenues from new forms of business taxation. Furthermore, there are important possibilities in extensions of the principle of grants to towns and cities from state authorities. It will be surprising if the next few years fail to show an increasing tendency toward centralization of school administration, with an accompanying resort to partial state collection of funds and subsequent grants to local treasuries from state authorities. In view of these possibilities, it has hardly yet been demonstrated that city schools must be financed as largely as in the past from the proceeds of the general property tax.

In his analysis of the elements of school expenditure, Mr. Burgess is upon more solid ground. The first chapter of his book deals with the mounting costs of education

in this country. It is pointed out that the amount now spent for public schools is nearly twelve times that spent in 1870, though the number of school children is only four times as great. Furthermore, it is observed that school costs are rising with a constantly increasing increment, the rate of increase in expenditures being slightly in excess of five per cent per annum.

The course of rising school costs is studied in the trend of teachers' salaries and building costs. The method of determining these trends is to be carefully noted. In practically all cases, Mr. Burgess accepts as the trend the line of regression obtained by correlating the variable with time, and in most cases the period of fit is the 75-year span from 1841 to 1915.*

Examination of the various trends obtained in this fashion raises a serious question of method. Nearly all of the series included in the study are series of money items: total school expenditures, weekly salaries of teachers, the cost of living, artisans' wages, the cost of building materials. All of these series are materially affected by changes in the general level of prices. As a consequence, the several series reflect unmistakably the price episodes which have marked the economic and financial history of the country since 1841. The period from 1841 to 1861 is altogether different from the period of paper money inaugurated with the first issue of greenbacks in 1862. The rapidly rising prices of the greenback period bring experiences quite unlike those of the years of declining prices from 1873 to 1896. Later, the rapidly rising prices of the period from 1897 to 1913 have far-reaching consequences which are magnified many-fold during the price revolution since 1914. Teachers' salaries and building costs, like all other pecuniary phenomena, have been fundamentally influenced by general price movements. The relations between teachers' salaries and the cost of living, between teachers' salaries and wages of laborers and artisans, are quite different in periods of rising and of falling prices. To undertake an analysis of the trend from 1841 to 1920, without explicit and careful consideration of the several distinct chapters of monetary experience included within these seventy-five years, seems to attempt broad generalization at the expense of accurate diagnosis. The study of trends would be much more valuable if it carefully recognized the differences of trend in the successive periods of general price history.

The many direct comparisons of the several series presented in the book are much more instructive. The differences between teachers' salaries in city and country are striking. The relation between teachers' salaries and the wages of laborers and artisans is highly significant. The comparative course of teachers' salaries and the cost of living discloses the basic fact that teachers' salaries have gained on the cost of living during periods of declining prices and have ordinarily lost ground during periods of rising prices. Comparison of teachers' salaries with the cost of living as well as with wages of laborers and artisans suggests essential relationships between the underlying tendencies of the price level and the *real* compensation of government employees. The subject will repay further investigation. Burgess' analysis makes an excellent beginning for those government employees engaged in the important work of public education.

Trends of School Costs contains a substantial body of interesting and valuable information. The index numbers for teachers' salaries are an excellent compilation, and the study of building costs throws strong light upon an important subject. Although further details regarding the original data and the methods by which they

* In computing the coefficients of regression and correlation, Ayres' shorter method is employed. See *Journal of Educational Research*, April and May, 1920. Where the trend of the series is curvilinear, no real fit is attempted; but the difference between the first and the last items is assumed to have accumulated geometrically and a compound interest curve is drawn between the two.

have been combined would seem desirable in some instances, there is no reason for questioning seriously any of the important series developed in the analysis. In general, the book seems more serviceable in particular parts than as a whole. Despite its title, it seems least valuable in its study of "trends." For the greater part, the trends are unconvincing because determined without regard to fundamental changes in the level of prices. Upon the other hand, the direct comparisons of the several series are most instructive and make the book a valuable contribution to the understanding of public school administration.

EDMUND E. DAY.

Eighty-First Annual Report of the Registrar General of Births, Deaths, and Marriages in England and Wales, 1918. Cmd. 608, London, 1920. Pp. 450.

The Registrar General's reports of births, deaths, and marriages for England and Wales set a standard that other countries might well follow, and the 1918 report is up to the usual high mark. This volume contains the usual tables, among which are tabulations of births, deaths, and marriages under various classifications and in addition, tables giving the estimated populations for different classes of people in the country, the balance of inward and outward passenger movement, and meteorological data. These last three tables are not so common as they should be in reports on vital statistics.

The part of the volume devoted to the discussion of special diseases has been increased by the addition of sections treating malaria, diphtheria, and croup, influenza, dysentery, tubercle of the peritoneum and intestines, encephalitis and cerebro-spinal fever.

The effect of the influenza epidemic on the death-rate is discussed, and death-rates have been computed excluding the excess deaths due to influenza. The conclusion arrived at is that except for the epidemic the general health of the people was if anything better than that of previous years.

Among the special discussions of interest is one on the effect of the war on the marriage rates for different parts of England and Wales. While the marriage rate for the whole country for the year 1918 is slightly lower than the average prior to the war, the rate for rural and residential counties shows considerable increase, due probably to the shifting of the population caused by the war.

The increase of male births over female births since the beginning of the war is shown in the following table which gives the number of male births per 1,000 female births for each quarter of the years 1914 to 1918.

	First quarter	Second quarter	Third quarter	Fourth quarter
1914	1,031	1,037	1,031	1,043
1915	1,031	1,042	1,044	1,043
1916	1,050	1,051	1,045	1,050
1917	1,042	1,042	1,043	1,049
1918	1,043	1,046	1,048	1,056

This table, taken with the fact that prior to the war the highest ratio was that of the year 1875 when the ratio was 1,043 male births to 1,000 female, shows that there has been a striking increase in masculinity among the births since the beginning of the war. The possibility that this may be due to the marked increase in marriages immediately following the beginning of the war is discussed and rejected.

One criticism that might well be made of the report is that no mention of still-births is to be found. It is unfortunate that an item as important as this should be omitted from the Registrar General's reports.

L. J. REED.

Birth Statistics for the Birth Registration Area of the United States, 1918. Fourth Annual Report. Bureau of the Census. Washington, 1920. Pp. 312.

Since the appearance of the first annual report on birth statistics for the year 1915, these reports have been steadily enlarged until in the present report we have as fine a record of birth statistics as is published by any country. The registration area for the 1918 report contains 53 per cent of the population of the United States. Since no change was made in the registration area during 1918, the figures in the present volume cover the same area as those of the 1917 report. It is important to note that all tables given in the volume for 1917 are repeated for the year 1918; comparisons, therefore, can be made between the two years for all the material published for 1917. The 1918 report, however, contains much additional information, relating particularly to infant mortality rates and to still-births.

The new tables on infant mortality rates show urban and rural infant mortality rates, and seasonal infant mortality rates in total and for special diseases. The information in both of these tables is given for the registration area as a whole and for each registration state.

The tabulations of still-births are to be commended particularly. In these tables can be found information relating to sex, color, month of birth, birth order, age, and country of birth of father and of mother, for still-births in the registration area for 1918.

One further additional table contained in the 1918 volume is that showing the number of mothers having a specified number of children born with the average number living, and the per cent of mothers having specified numbers of children living by color, and for white mothers, by country of birth.

While it is not possible to present in a review of this kind many of the tabulated results of the report, it is perhaps worth while to note the trend of the birth-rate in the registration area. The report gives the following tabulation:

Year	Rate per 1,000 population	
	Births	Deaths
1915	24.9	14.0
1916	24.8	14.7
1917	24.6	14.1
1918	24.4	18.2

Taken as a whole the report is very complete and the Census Bureau is to be congratulated on its work.

L. J. REED.

The Inequalities of Incomes. By Hugh Dalton, M.A. London, George Routledge & Sons, Ltd.; New York, E. P. Dutton & Company, 1920. Pp. 360.

Mr. Dalton has set himself the problem of inquiring into the causes of the extreme inequality of incomes which exists. A thorough examination of past theories of distribution leads him to the conclusion that none of them has really solved the problem, and few have even envisaged it as an actual distribution between persons. The

constructive portion of his book is then divided into the part on "The Division of Incomes between Categories" and that on "The Division of Income between Persons." Income is defined in terms of economic welfare, which may best be measured in terms of money, provided that the part of money income which does not increase economic welfare (*i. e.* business expenses, taxes, and gifts) is excluded, and that a money equivalent for "real" income is added (p. 162 *et seq.*).

The division of income between its two chief sources, *i. e.*, ownership of property and the performance of work, is found to rest on the relative elasticities of demand and supply of these two items. He comes to the general conclusion in agreement, on the whole, with Pigou, that the absolute share of any factor of production, as a result of an increase in its supply, varies according as its elasticity of demand is greater or less than one; and that its relative share varies according as its elasticity of demand is greater or less than the reciprocal of the fraction expressing the total share of all the other factors of production. The application of these principles to the division of income between work and property, leads to the conclusion that as the supply of either increases, the absolute shares of each will increase. With regard to the relative division, he finds that the share of property is likely to increase in the future owing to the greater elasticity of supply of property. This portion of the work is highly suggestive, and the theoretical argument is presented with great skill. It is a pity that Mr. Dalton has not based his work on statistical material, or at least has not followed up his conclusions with statistical examples.

When we turn to the division of income between persons, there is clear evidence that this is the portion of the book on which the author has turned not only his brain but his heart. "The waste of potential human welfare, which great inequality involves, is the central idea upon which the various enquiries undertaken in this book are designed to converge" (p. 239).

Income from civil rights (old age pensions, war pensions, health and unemployment insurance, and the like) Mr. Dalton finds, on the whole, tend to equalize conditions of welfare. Such income-bearing civil rights, should therefore be encouraged.

The differences in income from work depend partly upon the amount of work done, and partly upon its value. Special agreements and legal enactments, limiting the hours of work or the conditions of competition, have an influence. Moreover, the freedom to choose a given occupation, which involves the ability to spend the requisite number of years in attaining a high degree of skill, also plays its part. But all of these differences are of relatively small importance, and subject easily to change by government.

It is when we come to the inequality which is due to the inheritance of property that we find the really important problem. Here the inequalities are far greater than in the incomes from work. "The phenomenon of inherited wealth is at once very curious, very important, and very much neglected" (p. 281).

The writer finds that this institution promotes social stratification, and that it is advancing at an ever accelerating pace. No longer is it true that there are three generations between shirt-sleeves and shirt-sleeves; indeed, "the rich by inheritance, have a position which they can lose only by a destructive tendency amounting almost to madness" (p. 283). Again it is unfortunate that Mr. Dalton does not reënforce his argument by a wider use of statistics. He next proceeds to discuss various schemes for the limitation of inheritances. Under this head, he gives enthusiastic support and approval to the original device propounded by Professor Rignano. This plan is to tax at an increasing rate that part of a fortune which passes through more than one generation, so that in a comparatively short time it will be wiped out alto-

gether. Thus, a son would inherit two-thirds of his father's estate, but could pass on only a small portion of this sum. In order to leave a large bequest, he must earn money on his own account. He believes that the perplexities in connection with the practical application of this scheme—such as the separation of the property into that which is inherited, and that which is earned, and the reduction of gifts *inter vivos*—could be successfully solved.

Another little-known idea brought forward is that of Professor Pigou, that all inheritances should be settled on public trustees, who should control the property in the public interest and pay over the income to the beneficiary. Among the other reforms advocated are the abolition of primogeniture, a narrowing of the rights of relatives in the property of intestates, and the limitation of the amount of any individual inheritance.

If any criticism is to be offered of this spirited and scholarly treatise, it is that the groundwork is not sufficiently well laid. What are the amounts involved? How great are the inequalities of income? How many people would be adversely affected by the carrying out of the proposed reforms? To what extent would the community at large be benefited? With the exception of a few limitations (pp. 202, 207), a favorable answer to all these questions is assumed; and yet it can scarcely be said that the correct answers to them all are matters of common knowledge.

Oswald W. Knauth.

National Bureau of Economic Research, New York.

Readings and Problems in Statistical Methods. By Horace Secrist, Ph.D. New York, The Macmillan Company, 1920. Pp. xi, 427.

In recent years books of readings have come to serve as valuable supplements to regular text-books in many courses of study. In perhaps no field has the instructor felt more the need for a well-selected book of readings than in the field of statistics. The limitation of space necessarily compels the author of a text-book on statistics to confine himself largely to a discussion of general principles and methods. The study of statistical principles, however, except perhaps as an exercise in logic or mathematics, serves no valuable purpose in itself; it is useful only as a means of furnishing a tool for the conduct or understanding of actual investigations of concrete problems. Consequently, every teacher of the subject has doubtless recognized the desirability of bringing to the attention of his students examples of the application of statistical methods in the analysis of practical problems. Satisfactory illustrative material, however, must be gathered from numerous sources, and if the instructor's class is large, or if its ready access to the material is not feasible, a severe handicap in instruction is experienced. A compact volume of readings, carefully chosen to show the use of statistical methods in actual investigations, would go far toward overcoming these difficulties.

Although it is the opinion of the reviewer that such a collection of readings would meet the greatest need, it is quite possible to arrange a collection with other purposes in view. For example, the selections might be chosen simply with the idea of amplifying the theoretical discussions of a text-book, or an attempt might be made to make the readings serve as a complete text in themselves, with perhaps the inclusion of certain selections for illustrative purposes. Compilers of books of readings may differ in their conceptions of the proper functions of such a book; but, whatever it may be, some well-defined purpose should exist in the compiler's mind and should be adhered to in his choice of readings. If an attempt is made to compile a collection which will serve several purposes at once, there is danger that no purpose will be adequately served.

In the introduction to Professor Secrist's volume, it is stated that selections were chosen "to illustrate concretely the attitude of mind in which statistical analysis must be undertaken and to develop logically the steps and processes through which statistical data must be carried in order to be used as bases for logical inferences." The selections are intended to constitute within themselves an independent treatment of statistical principles, but it is expected that they will have their greatest value when used in connection with a text on statistical methods and are intended primarily for use in this manner. Their use in connection with the compiler's own text-book, *An Introduction to Statistical Methods*, is considerably facilitated by the employment of the same chapter headings in both volumes. The readings include selections dealing with the usual subdivisions of statistical methods—the collection of data, classification and tabulation, diagrammatic presentation, averages, index numbers, summarization, and comparison. They are drawn from various sources such as government reports, special studies, statistical and economic journals.

In the choice of readings the volume suffers from the attempt to serve too many purposes. Doubtless the desire of the compiler to make the readings serviceable independently as a text led him to include many selections that are purely abstract discussions of statistical principles and their uses. But such selections are not inclusive enough or well enough coördinated to enable them to answer adequately the requirements of a general text. For instance, the chapter entitled "Description and Summarization—Dispersion and Skewness," contains nothing whatsoever explaining the various measures of dispersion and skewness. Similarly, the selection in the following chapter dealing with correlation would not be understandable to the beginner in the study of statistics without supplementary reading in a text. The book contains too many gaps in the exposition of the elements of statistical methods to make it in itself a satisfactory dependence for general text-book purposes.

As the compiler states, however, the readings are intended primarily for use in connection with a text on statistical methods, and it is the opinion of the reviewer that this is the only way in which they could be used satisfactorily. But if a text must be used along with the readings, it would seem that the space devoted to the abstract discussion of theory and methods could have been much reduced without loss to the student. This would be true, for example, of practically the entire chapter on tabular presentation, which is devoted to an exposition of general principles with no concrete illustrations. The omission of such selections would have made possible the inclusion of much more material illustrative of the practical application of statistical methods in actual investigations—a type of material which, as stated above, it is believed would fill the greatest need in the teaching of statistics. There are some excellent specimens of this type included in the *Readings*. For example, the one from Chaney and Hanna's *The Safety Movement in the Iron and Steel Industry, 1907 to 1917*, in connection with the study of units of measurement; also, several selections from Professor Davis R. Dewey's Report on "Employees and Wages" in the *Twelfth Census*. It is regrettable that more readings of this type were not substituted for some of the abstract discussions. In the introduction, the compiler states that his purpose has been to emphasize the use of statistics. But would the student not be much more impressed with the use of statistics in business, for instance, by a concrete example of the statistics actually collected and used by some business organization, than by a general discourse upon the subject?

It is believed that the serviceableness of the readings could have been greatly enhanced by thus placing greater emphasis upon the application of statistical methods in the choice of selections. Nevertheless, both the student and the instructor will find this volume a useful aid in the study of statistical methods. Through it ready

access is provided to supplementary and illustrative material that for many would otherwise be unavailable. The value of the volume for pedagogical purposes is enhanced by the inclusion, at the end of each important article, of questions which should prove stimulative to the thinking of the student along collateral lines as well as suggestive of practical problems to which they may relate. Review problems at the end of all ten chapters except the first three provide material for the much needed exercises or laboratory work in connection with courses in statistical methods. The author is more or less apologetic for the inclusion of these problems, but unduly so; no instructor in statistics will begrudge them the few pages of space that they occupy and all, on the contrary, should welcome them as a valuable aid in teaching.

WILLIAM O. WEYFORTH.

The Johns Hopkins University.

Workingmen's Standard of Living in Philadelphia. By William C. Beyer, Rebekah P. Davis, and Myra Thwing. New York, The Macmillan Company, 1919. Pp. x, 125.

Among the many attempts to measure living costs, this report of the Bureau of Municipal Research of Philadelphia must be awarded high rank. In 1917, the Bureau undertook to establish a living wage to serve as a basis for the payment of manual laborers in the employ of the city. Thoroughly alive to the fact that any estimate in terms of money would have but momentary value, the Bureau determined to derive such a "goods standard" that its money equivalent could be calculated at frequent intervals.

In arriving at the "goods standard," experts on diet, housing, and industrial relations were consulted, and the work of Chapin, of Cotton and Little, and of the War Labor Board was studied; but main reliance was placed upon a new investigation among self-supporting families of Philadelphia manual laborers whose principal bread-winner did not earn more than $2,000 a year. As usual, the attempt to induce families to keep accurate accounts met with little success. The best data were secured by skilful personal interviews based upon an elaborate schedule. The answers of each housewife were tabulated, and the estimated expenditures checked with the income. If there was a larger discrepancy between income and disbursements than five per cent, the schedule was rejected. Great emphasis was placed upon obtaining quantities of goods used as well as payments.

The conclusions are presented at length in the fourth chapter. The standard of living consists of (1) a two-story row house with six rooms, a bathroom, a laundry, a furnace, and gas for cooking and lighting; (2) five tons of coal, 26,000 cubic feet of gas, and fifty-two boxes of matches; (3) food in amounts specified for a family of five individuals with the consuming capacity of 3.80 adult males; (4) clothing, the articles needed by each member of the family being listed in detail; (5) car fares for 708 rides; (6) certain cleaning and toilet supplies; and (7) the unspecified standard. The lists in groups (1) to (6) are very detailed and complete. After their money cost has been determined, 21 per cent is added for group (7), comprising health, furnishings, taxes, recreation, education, insurance, and other miscellaneous items. In the fall of 1918, the money equivalent of this standard was $1,636.79.

The authors recommend that this goods standard be revised at least once in five years, and that its money equivalent be calculated annually in order to fix minimum wages for adult males in unskilled manual municipal employments. They suggest that similar standards be devised for other classes of workers.

Any estimate of a cost of living is an easy target for criticism as to minutia. It is hard to imagine, for example, a manual laborer's making a pair of hose supporters

last for a whole year, or five twenty-five cent tooth-brushes' cleansing five sets of teeth 1,095 times apiece. On the other hand, the authors frankly recognize the difficulties in their way and show that each item is the result of careful study. They proclaim that the standard is based upon conditions in Philadelphia in 1918. They would be the first to admit that their standardized Philadelphia house hardly exists in Indianapolis or in New York, or that their annual dietary might be difficult of realization in New Orleans or in Bangor.

The working-out of a standard expressed in goods has long been the goal of persons interested in the cost of living. This book is a welcome contribution to the solution of the problem.

FRANK H. STREIGHTOFF.

Indiana University.

Animal Foodstuffs, Their Production and Consumption with a Special Reference to the British Empire. By E. W. Shanahan. London, George Rutledge and Sons; New York, E. P. Dutton and Company, 1920. Pp. viii, 313.

If the professors of economics and political science in American universities wish to blush, the following recipe is recommended:

Select at random five doctors' dissertations in those fields, approved by each of ten American graduate schools, and compare them with E. W. Shanahan's thesis on *Animal Foodstuffs* presented for the degree of doctor of science in the University of London.

In the preface Dr. Shanahan says:

"An attempt has been made in this inquiry to survey quite impartially the productive resources of all important parts of the world in respect of animal foodstuffs. This has involved a great deal of detailed research. Throughout this part, and indeed throughout the whole of the investigation, the close relationship between animal foodstuffs and concentrated feedstuffs has been insisted upon. The main conclusion drawn has been that the supplies of animal foodstuffs tend at present, and are still more likely in the near future, to be deficient.

"This has led to an inquiry into the economic position of animal industries in agriculture, into their costs of production, and into the economics of consumption in relation to production in respect to them. All these have been studied in their bearing upon future movements. No distinct attempt, however, has been made to deal with the subject of marketing which arises in this connection since the field appeared too wide and the questions too complex and technical for adequate discussion."

The 318 pages of text are divided among Part I, Production—192 pages; Part II, Consumption—82 pages; and Part III, The Production and Consumption of Animal Foodstuffs in the British Empire—42 pages.

The author says that it is a study in economic geography and agricultural economics. His utilization of agricultural economics is excellent; and if his mastery of geography had been as thorough as his mastery of agricultural economics, the book would indeed have been a very great treasure. It is a treasure, nevertheless; but like most economists, he assumes that he can deal with geography without knowing much geography other than the locational variety. His apparent ignorance of the fundamental facts and factors of climate has caused a few slips and misappreciations in a book which shows a very careful and wide survey of the literature bearing upon the meat producing resources of the world.

The food supply has become a world problem, and the recurrence and utilization of this background fact in the book is most useful.

Dr. Shanahan's thesis is a valuable addition to my book-shelf.

J. RUSSELL SMITH.

Columbia University.

RECENT LITERATURE

STATISTICAL BOOKS

Bernhardt, Joshua. Government control of the sugar industry in the United States. An account of the work of the U. S. Food Administration and the U. S. Sugar Equalization Board, Inc. New York, Macmillan Co., 1920. x, 272 pp.

Bureau of Applied Economics, Inc. Washington. Standards of living, a compilation of budgetary studies. (Revised edition.) Washington, 1920. Bulletin No. 7. 156 pp.

Commons, John R. Races and immigrants in America. New ed., New York, The Macmillan Co., 1920. xxix, 242 pp.

Dewey, E. and others. Methods and results of testing school children. Manual of tests used by the psychological survey in the public schools of New York City, including social and physical studies of the children tested. New York, E. P. Dutton and Co., 1920. xii, 176 pp.

Dewing, Arthur S. The financial policy of corporations. New York, The Ronald Press Co., 1920. 5v. Volume. 1. Corporate securities. 2. Promotion. 3. The administration of income. 4. Expansion. 5. Failure and reorganization.

Drachsler, Julius. Democracy and assimilation: the blending of immigrant heritages in America. New York, The Macmillan Co., 1920. xii, 275 pp.

Fernald, M. R. and others. A study of women delinquents in New York State. New York, The Century Co., 1920. xviii, 542 pp.

Hare, Sir Lancelot. Currency and prices. London, P. S. King and Son, 1920. 74 pp.

Institute international d'Agriculture. Annuaire international de statistique agricole, 1917 et 1918. Rome, Imprimerie de l'Institut international d'Agriculture, 1920. xlix, 747 pp.

Kemmerer, E. W. High prices and deflation. Introduction by F. A. Vanderlip. Princeton, N. J., Princeton University Press, 1920. xii, 86 pp.

Lehfeldt, R. A. Gold, prices, and the Witwatersrand. London, P. S. King and Son, Ltd., 1919. 130 pp. (London School of Economics and Political Science. Studies, No. 54.)

Linhart, G. A. A new and simplified method for the statistical interpretation of biometrical data. (University of California. Agricultural sciences. v.4. No. 7. September 10, 1920. 159–181 pp.)

Pollock, H. M. A statistical system for the use of institutions for criminals and delinquents. (Report of Committee "J" of the Institute.) 13 pp. Presented at the annual meeting of the American Institute of Criminal Law and Criminology at Indianapolis, September 16–18, 1920.

Redmayne, R. A. S. and Stone, Gilbert. The ownership and valuation of mineral property in the United Kingdom; being an elementary treatise on the nature of mineral interests and royalties, and the correct method of valuing such property for the purposes of sale, probate, and rating and taxation, together with a statement of the law relating to rating and taxation. New York, Longmans, Green and Co., 1920. vii, 256 pp.

Rosenfeld, Siegfried. Die Anderungen der Tuberkulosehäufigkeit Oesterreichs durch den Kreig. Wien, Verlegt vom Volksgesundheitsamt im Staatsamte für soziale

Verwaltung für den Buchhandel bei F. Deuticke in Wien und Leipzig, 1920. 112 pp.

Williams, John Henry. Argentine international trade under inconvertible paper money 1880–1900. Cambridge, Harvard University Press, 1920. xiv, 282 pp. Harvard Economic Studies, 22.

Yule, G. Udny. The fall of the birth-rate. A paper read before the Cambridge Eugenics Society, 20 May, 1920. Cambridge, At the University Press, 1920. 43 pp.

GOVERNMENT PUBLICATIONS

Amsterdam

Amsterdam. Bureau van Statistiek. De gemeentelijke inkomstenbelasting in de belastingjaaren 1917–18, 1918–19, en 1919–20. Voorloopige cijfers volgens de kohieren, derhalve vóór reclame en zonder ontheffingen en oninbare bedragen. Amsterdam, J. Müller, 1920. 15 pp.

—— —— De gemeentelijke inkomstenbelasting in het belastingjaar 1916–17. Amsterdam, J. Müller, 1920. 31 pp.

—— —— Maandbericht, July to September, 1920. Monthly statistics of births, marriages and deaths, prices, municipal finance, etc., with a summary each quarter.

Australia

Australia. Commonwealth Bureau of Census and Statistics. Finance: summary of Australian financial statistics, 1909–10 to 1918–19. Melbourne, 1920. 92 pp.

—— —— Pocket compendium of Australian statistics. 6th issue. Melbourne, 1920. 149 pp.

—— —— Prices, purchasing power of money, wages, trade unions, unemployment, and general industrial conditions, 1918. Melbourne, McCarron, Bird and Co., 1919. 268 pp.

—— —— Quarterly summary of Australian statistics. Bulletin, No. 80. June, 1920. Statistics of population and vital statistics, production, shipping and commerce, finance, railways, labour, prices, etc.

—— —— Trade and customs and excise revenue of the Commonwealth of Australia for the year 1918–19. Melbourne, A. J. Mullett, Government printer, 1920. 608 pp.

—— —— Transport and communication. Summary of Commonwealth statistics of transport and communication for the years 1909 to 1919. Melbourne, 1920. 60 pp.

Basel

Basel (Switzerland). Statistisches Amt. 50. Bericht über die Zivilstandsbewegung, die Todesursachen und die ansteckenden Krankheiten im Kanton Basel-Stadt, 1919. Basel, Buchdruckerei, J. Frehner, 1920. viii, 85 pp.

Canada

Canada. Dominion Bureau of Statistics. Monthly bulletin of agricultural statistics, August-November, 1920.

—— —— Finance Division. Municipal statistics. Report on cities and towns having a population of 10,000 and over. Ottawa, T. Mulvey, Printer, 1920. 57 pp.

Copenhagen

Copenhagen. Kommunal bestyrelses Foranstaltning. Tabellarisk Fremstilling af Befolkningens Fordeling efter Kon og Alder, Civilstand og Trossamfund, samt efter Fodesteds-og Ehrvervsforhold for Kobenhavn, Frederiksberg og Gentofte Kommune paa Grundlag af Folketællingen den 1. Februar 1916. Copenhagen, 1919. 25, 80 pp.

—— —— Tabellarisk Fremstilling af Ejendoms—, Beboelses- og Husleje-Forholdene for Kobenhavn, Frederiksberg og Gentofte Kommuner paa Grundlag af Folketællingen den 1. February 1916. Copenhagen, 1918. 65 pp.

—— Statistiske Kontor. Statistiske Oplysninger IX om Kobenhavn og Frederiksberg, 1913–1917. Copenhagen, Krohns Bogtrykkeri, 1919. xvi, 277 pp.

—— —— Statistisk Aarbog for Kobenhavn og Frederiksberg, 1919. Copenhagen, B. Lunos Bogtrykkeri, 1920. xv, 151 pp. (Annuaire statistique de Copenhague et Frédériksberg.)

France

France. Bureau de la statistique générale. Bulletin de la statistique générale de la France et du service d'observation des prix. Each number contains statistics of population, labor, production, transportation, foreign trade, prices, exchange, etc.

October, 1920. La protection légale de la première enfance et de la maternité.

Great Britain

Great Britain. Ministry of Labour. Labour gazette. October to November, 1920. Contains each month statistics of retail prices, employment, unemployment, work of employment exchanges.

October. Miners' federation of Great Britain: wages and prices demands. Dock workers: registration; payment of wages; maintenance during unemployment.

November. The effect of the coal strike on employment in other industries. Unemployment—remedial measures. Industrial co-operative societies in 1918.

—— Registrar-General.

Quarterly return of marriages, births, and deaths. October 30th, 1920.

Netherlands

Netherlands. Bureau central de statistique. Supplément à la statistique médicale de l'armée indo-néerlandaise pendant l'année 1917 comme contribution à la statistique médicale militaire internationale. La Haye, Belinfante frères, 1920. 8 pp.

—— Centraal Bureau voor de Statistiek. Faillissements-statistiek over de jaren 1917 en 1918. 's-Gravenhage, Gebrs. Belinfante, 1920. xxxiii, 31 pp. (Statistique des faillites dans les Pays-Bas pour les années 1917 et 1918.)

—— —— Justitieele Statistiek over het jaar 1918. 's-Gravenhage, 1920. xlvi, 121 pp. (Statistique judiciaire des Pays-Bas pendant l'année 1918.)

—— —— Maandschrift. September-November, 1920. Each number contains articles and statistics relating to the labor market, prices, cost of living, finance, transportation, etc.

—— —— Statistique des salaires et de la durée du travail des ouvriers dans les blanchisseries et dans les établissements pour le nettoyage à sec et teintureries assurés selon la loi sur les accidents du travail pendant 1917. 's-Gravenhage, Belinfante, 1920. xxx, 17 pp.

New York (State)

New York (State). Industrial Commission. The Bulletin. August-November, 1920. Each number contains sections devoted to the Bureau of Women in industry, Legal Bureau, Bureau of Inspection, etc.

October. Report of Bureau of Mediation and Arbitration on industrial disputes in New York State for the year ending June 30th, 1920.

—— —— Labor market bulletin. August-October, 1920. Employment in factories; course of average earnings and food prices; building activity in principal cities; labor supply and demand at state employment offices.

—— —— The telephone industry; prepared by the Bureau of Women in Industry. Albany, 1920. 95 pp.

—— State Probation Commission. Thirteenth annual report for the year 1919. Albany, 1920. 560 pp.

—— Secretary of State. Annual report on statistics of crime for the year ending October 31, 1919. Albany, 1920. 421 pp.

Norway

Norway. Departementet for Handel, Sjofart, Industri og Fiskeri. Poststyrelsen. Norges postvesen, 1919. Kristiania, H. Aschehoug & Co., 1920. xii, 82 pp. (Statistique postale pour l'année 1919.)

—— Direktoren for det civile Medisinalvesen. Sundhetstilstanden og medisinalforholdene 1916. 64 de Årgang. Kristiania, J. Bjornstad, 1920. vii, 159 pp. (Rapport sur l'état sanitaire et médical pour l'année, 1916, avec une carte.)

—— Direktoren for det civile Veterinaervesen. Veterinaervesenet og kjottkontrollen 1918. Kristiania, H. Aschehoug & Co., 1920. viii, 209 pp. (Le service vétérinaire et l'inspection de la viande, 1918.)

—— Forsikringsraadet. Forsikringsselskaper 1918. Kristiania, Aschehoug & Co., 1920. 41, 127 pp. (Sociétés d'assurances 1918. Rapport du Conseil d'Assurances.)

—— Hovedstyret for Statsbanene. Norges jernbaner. Beretning for året 1 Juli 1918–30 Juni 1919. Kristiania, H. Aschehoug & Co., 1920. lxviii, 292 pp. (Annuaire des chemins de fer norvégiennes 1918–1919.)

—— Justisdepartementet. Opgaver over den kriminelle rettspleie og benådninger for 1913 og 1914. Kristiania, H. Aschehoug & Co., 1920. 51 pp. (La justice criminelle: comptes de travail des tribunaux et les grâces pour les années 1913 et 1914.)

—— Kirke- og Undervisningsdepartementet. Behandlingen av forsomte barn, vergerådenes virksomhet, skolehjem og tvangsskoler (Lov av 6 Juni 1896), 1914 og 1915. Kristiania, H. Aschehoug & Co., 1920. 71 pp. (Statistique concernant le traitement des enfants moralement abandonnés. Années 1914 et 1915.)

—— Medisinaldirektoren. Sinnssykeasylenes virksomhet 1917. Kristiania, H. Aschehoug & Co., 1920. 4, 60 pp. (Statistique des hospices d'aliénés pour l'année 1917.)

—— Statistiske Centralbyrå. Alkoholstatistikk 1918–1919. Kristiania, H. Aschehoug & Co., 1920. 62, 51 pp. (Statistique de l'alcool 1918–1919.)

—— —— Kommunevalgene 1919. Kristiania, H. Aschehoug & Co., 1920. 18, 40 pp. (Élections en 1919 pour les conseils communaux et municipaux.)

—— —— Konferansen angaende arbeidsledighetsstatistikken i Kristiania 13–15 Mai 1920. Kristiania, Steenske Boktrykkeri, 1920. 35 pp. Tilleggshefte til "Meddelelser fra det statistiske centralbyrå" 1920.

—— —— Manedsopgaver over vareomsetningen med utlandet. May-September, 1920. (Bulletin mensuel du commerce extérieur.)
—— —— Meddelelser fra det Statistiske Centralbyrå, 1920, nr. 5–10. (Journal du Bureau Central de Statistique du Royaume de Norvège.)
—— —— Norges skibsfart, 1918, med forelobige oplysninger for 1919. Kristiania, H. Aschehoug & Co., 1920. 42 pp. (Statistique de la navigation de la Norvège pendant l'année 1918 avec des renseignements pour l'année 1919.)
—— —— Norges handel, 1918. Kristiania, H. Aschehoug & Co., 1920. 10, 227 pp. (Statistique du commerce de la Norvège pendant l'année 1918.)

PARIS

Paris. Préfecture de la Seine. Direction de l'Hygiene, du Travail et de la Prévoyance sociale. Service de la statistique municipale. Annuaire statistique de la Ville de Paris, XXXVe Année, 1914, et principaux renseignements pour 1915. Paris, Masson et Cie., Editeurs, 1920. xxxii, 695 pp.

PENNSYLVANIA

Pennsylvania. Department of Labor and Industry. Bulletin, Series of 1920. No. 6–7.

SOUTH AUSTRALIA

South Australia. Government Statist. Statistical register, 1918–1919. Compiled from official records. Adelaide, R. E. E. Rogers, 1919, v. p.

SWEDEN

Sweden. Armeéförvaltningens Sjukvårdsstyrelse. Hälso- och sjukvard vid armén år 1919. Stockholm, P. A. Norstedt & Söner, 1920. 96 pp.
—— Bank- och Fondinspektionem. Uppgifter om bankerna. September-October, 1920.
—— Ecklesiastik-Departementet. Statens allmänna läroverk läsåret 1918–1919. Stockholm, Centraltryckeriet, 1920. 72, 62 pp.
—— —— Statens normalskola för flickor och privatläroverken. (Högreflickskolor, högre goss-och samskolor samt enskilda mellanskolor.) Läsäret 1918–1919. Stockholm, 1920. viii, 130 pp.
—— Generalpoststyrelsen. Postverket år 1919. Stockholm, K. L. Beckmans Boktryckeri, 1920. x, 235 pp.
—— Järnvägsstyrelsen. Järnvägsstatistiska meddelanden. 1920. N:r 6–7.
—— Kommerskollegium. Industri, berättelse för år 1918. Stockholm, 1920. 169 pp.
—— —— Sjöfart berättelse for år 1918. Stockholm, P. A. Norstedt & Söner, 1920. xii, 138 pp.
—— —— Sveriges in- och utförsel av vissa varor. August-October, 1920.
—— Lantmäteristyrelsen. Lantmäteri år 1919. Stockholm, 1920. 118 pp.
—— Lotsstyrelsen. Lotsverket år 1919. Stockholm, 1920. 99 pp.
—— Medicinalstyrelsen. Allmän hälso- och sjukvard år 1918. Stockholm, 1920. x, 175 pp.
—— —— Det civila veterinärväsendet år 1918. Stockholm, 1920. vi, 79 pp.
—— Socialstyrelsen. Arbetsinställelser i Sverige år 1918. Stockholm, 1920. viii, 127 pp.
—— —— Betänkande med förslag till lag om hemindustriellt arbete. Stockholm, 1920. iv, 117 pp.

—— —— Kollektivavtal i sverige år 1919. Stockholm, 1920. vi, 48 pp.
—— —— Olycksafall i arbete år 1916. Stockholm, 1920. vi, 67 pp.
—— —— Statens förlikningsmäns för medling i arbetstvister verksamhet år 1918. Stockholm, 1920. 94 pp.
—— Statistiska Centralbyrån. Arealinventeringen och husdjursräkningen den 1 Juni, 1919. Stockholm, 1920. 81 pp.
—— —— Brottsligheten åren 1913 och 1914. Stockholm, 1920. viii, 175 pp.
—— —— Fiske år 1918. Stockholm, 1920. ix, 110 pp.
—— —— Mejerihantering år 1918. Stockholm, 1920. viii, 53 pp.
—— Statskontorets Fondbyrå. Utdrag ur under Kungl. Statskontorets förvaltning staendefonders och diverse medels räkenskaper för år 1919. Stockholm, 1920. 69 pp.
—— Telegrafstyrelsen. Telefon och telegraf år 1919. Stockholm, 1920. 268 pp.

Switzerland

Switzerland. Département fédéral des douanes. Statistique du commerce de la Suisse avec l'étranger en 1919. Bümpliz, 1920. 2v.
—— —— Statistique du commerce suisse. Rapport annuel, 1919. Berne, 1920. 96 pp.
—— Eidgenössisches Zolldepartement. Ein- und Ausfuhr der wichtigsten Waren. II Quartal, 1920. 79 pp.

Union of South Africa

Union of South Africa. Office of Census and Statistics. Official yearbook of the Union and of Basutoland, Bechuanaland Protectorate and Swaziland. No. 3, 1919, containing statistics mainly for the period, 1910–1918. Pretoria, 1920. xix, 975 pp.
—— —— Quarterly abstract of Union statistics, October, 1920. Contains statistics regarding population and social matters, cost of living, production, trade, transportation, finance, etc.

United States

United States. Bureau of the Census. 14th Census of the United States, 1920. Agriculture: number of farms, by states and counties, 1920, 1910, and 1900. Washington, 1920. 29 pp.
—— —— 14th Census of the United States. Population of cities, towns, villages, and boroughs having from 5,000 to 10,000 inhabitants: 1920, 1910, and 1900. Washington, 1920. 16 pp.
—— —— 14th Census of the United States: 1920. Census of Guam. 1920. 9 pp.
—— —— 14th Census of the United States: 1920. Bulletins: Population: Connecticut, Maryland, Massachusetts, New Hampshire, Rhode Island, Vermont. Agriculture: Delaware, New Hampshire.
—— —— Mortality statistics, 1919. Washington, 1920. 94 pp. Bulletin 144.
—— Children's Bureau. A summary of juvenile-court legislation in the United States by S. P. Breckinridge and H. R. Jeter. Washington, 1920. 110 pp.
—— Bureau of Education. Administration and supervision of village schools by W. S. Deffenbaugh and J. C. Muerman. Washington, 1920. 63 pp.
—— —— Correspondence study in universities and colleges, by A. J. Klein. Washington, 1920. 34 pp.
—— —— The eyesight of school children: defective vision as related to school

environment and methods of prevention and correction by J. H. Berkowitz. Washington, 1920. 128 pp.

—— —— Reorganization of science in secondary schools. A report of the Commission on the reorganization of secondary education, appointed by the National Education Association. Washington, 1920. 62 pp.

—— —— Requirements for the bachelor's degree by W. C. John. Washington, 1920.

—— —— Salaries in universities and colleges in 1920. Washington, 1920.

—— —— Statistics of normal schools, 1917–18, by L. E. Blauch and H. R. Bonner. Washington, 1920. 115 pp.

—— —— Statistics of public high schools, 1917–18. Washington, 1920. 192 pp.

—— —— The university extension movement, by W. S. Bittner. Washington, 1920. 124 pp.

—— Federal Reserve Board. Federal reserve bulletin, October-December, 1920. Each issue contains: Reviews of the month; business, industry and finance; prices; discount and interest rates; retail trade index; foreign trade index; physical volume of trade; operations of the Federal Reserve clearing system; resources and liabilities of the Federal Reserve Banks; condition of member banks in selected cities; etc.

October. Interbank accommodation. Development of principal commercial banks in England, Germany and France, 1914–1919. Economic and financial conditions in Chile.

November. Foreign exchange rates. Economic and financial conditions in Cuba. The investment trust as a channel for investment abroad.

December. The international financial congress at Brussels. Adjusting salaries of bank employees to meet changes in the cost of living. Gold reserves of the principal banks of issue, 1910–20.

—— —— New York. Monthly review of credit and business conditions in the Second Federal Reserve District, October-December, 1920.

—— Federal Trade Commission. Report on commercial wheat flour milling, September 15, 1920. Washington, 1920. 118 pp.

—— Bureau of Fisheries. Statement of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., and Portland, Me., by American and Canadian vessels during the month of August, 1920. Same, October, 1920.

—— —— Statement of quantities and values of certain fishery products landed at Seattle, Wash., by American fishing vessels during the month of October, 1920. Same, November, 1920.

—— Bureau of Foreign and Domestic Commerce. Monthly summary of foreign commerce of the United States. August-October, 1920.

—— —— Quarterly statement of imported merchandise entered for consumption in the United States during the quarters ending March 31, and June 30, 1920.

—— Fuel Administration. The report of the distribution division, 1918–1919. Part III. Statistical tables, by C. E. Lesher. Washington, 1919. 871 pp.

—— Geological Survey. Consumers' stocks of bituminous coal, March 1, and June 1, 1920. Report of inquiry by United States Geological Survey, Department of the Interior in coöperation with United States Bituminous Coal Commission and the council of National Defense. 31 pp. mim.

—— Bureau of Labor Statistics. Monthly labor review, October-November, 1920. Each number contains sections devoted to prices and cost of living, wages and hours of labor, employment and unemployment, etc.

October, E. P. Marsh: Wage adjustments in California oil fields. Changes in union scale of wages and hours of labor, 1913 to 1920. Wages in Italy, 1914 to 1919.

November. A. Maylander: Woman labor in Germany during the war.

—— Bureau of Mines. Refinery statistics, July-October, 1920.

—— Public Health Service. Public health reports. Weekly. October 1–December 24, 1920. Each number contains: Deaths during the preceding week; prevalence of disease—U. S., foreign and insular.

October 1. L. L. Lumsden: Coöperative rural health work of the Public Health Service in the fiscal year 1920.

October 8. C. E. A. Winslow and L. Greenburg: A study of the dust hazard in the wet and dry grinding shops of an axe factory.

October 15. E. L. Scott and A. B. Hastings: Some phases of protein catabolism and fatigue. Birth statistics and infant mortality, 1919.

October 29. W. C. Purdy: Biological investigation of California rice fields relative to mosquito breeding: Progress report.

November 5. L. A. Rieser: Typhoid reduction in South Carolina; comparative results in counties with and without health organizations.

November 12. J. Goldberger and others: A study of the relation of family income and other economic factors to pellagra incidence in seven cotton-mill villages of South Carolina in 1916.

November 19. Industrial morbidity statistics; report of the Committee on Industrial Morbidity Statistics, section on Vital Statistics, American Public Health Association, 1920. Principal causes of death in U. S. registration area, 1919.

November 25. E. Sydenstricker and W. I. King: A method of classifying families according to incomes in studies of disease prevalence.

December 3. Sickness frequency among industrial employees: Disease prevalence among wage-earners during the first half of the year 1920. Principal causes of death among insured wage-earners. Comparisons, by color, of the death-rates for the third quarters and the first nine months of 1918, 1919, and 1920.

December 17. M. F. Boyd and W. F. Fox: An epidemiological study of an endemic focus of leprosy. The notifiable diseases: Prevalence during 1919 in cities of over 100,000.

December 24. M. L. King and E. Sydenstricker: Venereal disease incidence at different ages. A tabulation of 8,413 case reports in Indiana.

—— Railroad Labor Board. Average daily and monthly wage rates of railroad employees on Class 1 carriers. In effect under private control (December, 1917); under the U. S. Railroad Administration (January, 1920); and under decision No. 2 (July 20, 1920), U. S. Railroad Labor Board. Chicago, Ill., August, 1920. Wage Series, Report No. 1. 12 pp.

—— Bureau of War Risk Insurance. Military and naval insurance and military and naval compensation claims as a result of the world war. June 30, 1919. Washington, 1920. 162 pp.

Western Australia

Western Australia. Government Statistician. Quarterly statistical abstract, No. 218–219. 1920. Perth, 1920.

ARTICLES IN PERIODICALS

American Labor Legislation Review. September, 1920. Review of labor legislation, 1920.

L'Economista. Weekly Sept. 26–Nov. 28. Contains each month articles and statistics relating to wholesale prices and the financial market.

October 10. B. Stringher: Note su la circolazione cartacea, gli scambi e i cambi con l'estero. M. A. Silvestri: Il capitale straniero in Romania.

October 17. R. Bachi: Numeri-indici delle quantità di merci importate ed esportate.

October 31. Contains supplement: Variazioni sui cambi dal 1914 al giugno 1920 a Ginevra.

November 7. R. Bachi: Gli stabilimenti dell'alta banca in Italia nella loro distribuzione geografica.

Giornale degli economisti e rivista di statistica. August-October, 1920.

August. G. Borgatta: Contributi critici alla finanza teoretica. G. Mortara: Fantasia e realtà nel calcolo delle recenti tavole di mortalita inglesi. V. Castrilli: Gli invalidi di guerra.

September. B. Turroni: Solidarieta economica e concorrenza commerciale fra gli stati.

October. Carlo di Nola: Gli odierni aspetti dell'economia dei trasporti. I porti, la loro reciproca concorrenza, la loro funzione economica.

Institute International de Statistique. Bulletin mensuel de l'Office permanent. May and August, 1920. Each number contains wholesale prices and index numbers of wholesale prices for various countries.

Journal of the Institute of Actuaries. October, 1920. D. C. Fraser: Newton's interpolation formulas. G. U. Yule: A note on Mr. King's method of graduation and its relation to graphic method. E. H. Lever: On obtaining values of life annuities at isolated rates of interest.

Journal of the Royal Statistical Society. July, 1920. J. B. Guild: Variations in the numbers of live stock and in the production of meat in the United Kingdom during the war. G. Findlay Shirras: Some effects of the war on gold and silver. Wholesale prices of commodities in 1919 by the Editor of the Statist. C. Ottolenghi: Index numbers of wholesale prices in India during the war. H. L. Trachtenberg: The reaction of life tables to the Makeham law.

Journal of Political Economy. October-November, 1920.

October. W. Notz: International private agreements in the form of cartels, syndicates and other combinations. W. A. Paton: Interest during reconstruction.

November. L. C. Marshall: Incentive and output: A statement of the place of the personnel manager in modern industry.

Metropolitan Life Insurance Co. Statistical bulletin, Sept.–Dec. 1920. Each number contains the mortality record of the preceding month.

September. Infant mortality in 1919. Syphilis the chief factor in the mortality of the insane. Army and navy anti-typhoid innoculation and the decline in typhoid fever mortality.

October. Effect of cancer upon the length of life. Some practical results of malaria control measures.

Quarterly Journal of Economics. November, 1920. A. B. Wolfe: Savers' surplus and the interest rate. R. H. Tawney: The British coal industry and the question

of nationalization. L. Einaudi: Taxes on property and property increments in Italy.

Review of Economic Statistics. (Harvard University Committee on Economic Research.) November, 1920. Monthly survey of general business conditions. An index of the physical volume of production: III. Manufacture, 1899–1919.

Revue d'Économie Politique. September-October, 1920. D. J. Gheorghiu: La situation monétaire de la Roumanie. Régime sous l'occupation ennemie et état actuel. A. Girault: Le morcellement parcellaire en France.

Supreme Economic Council. Monthly bulletin of statistics. Each number contains statistics of production, trade and shipping, price movements, finance and labour in various countries.

OTHER BOOKS

Ashley, Percy. Modern tariff history. Germany—United States—France. 3d ed. New York, E. P. Dutton and Co., 1920. x, 365 pp.

Barnich, G. Essai de politique positive basée su l'énergetique sociale de Solvay avec tableau de synthèse sociale. Bruxelles, Office de publicité, Lebègue & Cie., 1919. 413 pp.

Cannons, H. G. T. Bibliography of industrial efficiency and factory management. (Books, magazine articles, etc.,) with many annotations and indexes of authors and subjects. London, G. Routledge and Sons, New York, E. P. Dutton, 1920. viii, 167 pp.

Frachtenberg, Leo J. Alsea texts and myths. Washington, Government printing office, 1920. Bureau of American Ethnology, Bulletin 67. 304 pp.

Kirtkbride, F. B. and others. The modern trust company; its functions and organization. An outline of fiduciary banking. 5th ed. rev. and enlarged. New York, The Macmillan Co., 1920. xviii, 549 pp.

Robertson, Dennis H. A study of industrial fluctuation. An inquiry into the character and causes of the so-called cyclical movements of trade. London, P. S. King and Son, 1915. xiii, 285 pp.

Rolland, R. Clerambault; histoire d'une conscience libre pendant la guerre. 2d ed. Paris, Librairie Paul Ollendorf, 1920. 377 pp.

Stamp, J. C. British incomes and property: The application of official statistics to economic problems. London, P. S. King and Son, 1916. xv, 538 pp.

Westergaard, Harald. Editor. Losses of life in modern wars, Austria-Hungary; France, by Gaston Bodard, and Military selection and race deterioration by V. L. Kellog. Oxford, at the Clarendon Press, 1916. (Carnegie Endowment for International Peace. Division of Economics and History.) x, 207 pp.

Young Women's Christian Association. National Board. Community studies for Young Women's Christian Association workers in cities. New York, 1920. 57 pp.